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FINAL NATIONAL WILDLIFE REFUGE STUDY REPORT

04/05/1995

JACOBS ENGINEERING GROUP, INC.

NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA
INSTALLATION RESTORATION PROGRAM
FINAL NATIONAL WILDLIFE REFUGE STUDY REPORT

5 April 1995

Revision 0

PREPARED BY:
Southwest Division, Naval Facilities
Engineering Command
1220 Pacific Highway
San Diego, California 92132-5190

THROUGH:
CONTRACT #N68711-89-D-9296
CTO #0237
DOCUMENT CONTROL NO:
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WITH:
Jacobs Engineering Group Inc.
401 West A Street, Suite 1905
San Diego, California 92101

In association with:
International Technology Corporation
CH2M HILL

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LIST OF ACRONYMS

AA	atomic absorption
CDFG	California Department of Fish and Game
cd/kg	Cadmium per kilogram
CDWR	California Department of Water Resources
CLEAN	Comprehensive Long-term Environmental Action Navy
cm/sec	centimeters per second
COC	chemical of concern
COPCs	chemical of potential concern
CRDL	Contract-Required Detection Limits
Cr/kg	Chromium per kilogram
CSMW	California State Mussel Watch
CTO	Contract Task Order
DTSC	Department of Toxic Substances Control
EcoRA	Ecological Risk Assessment
DWR	Department of Water Resources
EDL	elevated data level
EIS	Environmental Impact Statement
ERM	effects range median
EPA	U.S. Environmental Protection Agency
ERL	effects range low
FS	feasibility study
ft/sec	feet per second

g	grams
GC/MS	gas chromatography/mass spectrometry
GERG	Geochemical and Environmental Research Group
HLW	Higher Low Water
IAG	Interagency Agreement
IAS	Initial Assessment Study
ICP	inductively coupled plasma
IRP	Installation Restoration Program
Jacobs	Jacobs Engineering Group Inc.
LLW	Lower Low Water
m	meters
MDL	method detection limit
mg/kg	milligrams per kilogram
MHHW	Mean Higher High Water
MHW	Mean High Water
ml	milliliter
MLLW	Mean Lower Low Water
MLW	Mean Low Water
mm	millimeters
MSD	matrix-spike duplicate
msl	mean sea level
MTL	maximum tolerable level
NAS	National Academy of Sciences
NCBP	National Contaminant Biomonitoring Program
ng/g	nanograms per gram

NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOEL	no-observed effects level
NOS	National Oceanic Service
NWR	National Wildlife Refuge
NWS	Naval Weapons Station
OCEMA	Orange County Environmental Management Agency
OU	operable unit
PACF	Patuxent Analytical Control Facility
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEL	probable effects level
POLB	Port of Long Beach
ppm	parts per million
QA/QC	quality assurance/quality control
RI	remedial investigation
ROD	Record of Decision
RPD	relative percent difference
RPM	Remedial Project Manager
RWQCB	Regional Water Quality Control Board, Santa Ana
SCS	Soil Conservation Service
SI	site investigation
SOP	standard operating procedure
SWDIV	Southwest Division, Naval Facilities Engineering Command

TOC	total organic carbon
TPH	total petroleum hydrocarbon
TSMP	Toxic Substances Monitoring Program
USDA	U.S. Department of Agriculture
USFDA	U.S. Food and Drug Administration
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

EXECUTIVE SUMMARY

The Seal Beach National Wildlife Refuge Study was conducted to assess the effects of operations at Naval Weapons Station (NWS) Seal Beach on the biota of the tidal saltmarsh at Seal Beach National Wildlife Refuge (NWR). The study focused on the potential bioaccumulation of chemicals in species that are the primary food items of the California Least Tern and the Light-Footed Clapper Rail, both of which are listed as endangered by the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (CDFG). These species are high on the food chain, thus could be most likely to be affected by bioaccumulation of chemicals. Chemical concentrations in sediments and the primary food species of the least tern and the clapper rail were assessed at locations throughout the NWR to evaluate the types and distribution of potential contaminants in the NWR. The Anaheim Bay watershed was characterized to provide information on types and potential sources of chemicals that could be contributed to the NWR from sources other than NWS Seal Beach. Sediment transport in the NWR tidal saltmarsh was assessed to evaluate patterns of erosion and deposition that influence the movement and distribution of potentially contaminated sediments within the NWR, as well as the potential for contamination to enter the NWR from the Anaheim Bay system. Habits of the organisms that are the primary food items of the clapper rail cause them to be in contact with and to ingest sediments. Contaminated sediments, therefore, could cause bioaccumulation in food organisms and in the birds that feed on them.

Results of sediment transport evaluation indicate that construction of four ponds by Port of Long Beach (POLB) at the landward ends of two of the three main channels of the NWR tidal saltmarsh has significantly changed sediment erosion and deposition patterns in the NWR. This has resulted from an increase in the volume and velocity of water flowing into the tidal channels of the NWR from the Anaheim Bay system during each tidal cycle. These changes are expected to result in a redistribution of sediments in the NWR over an unknown period of time and can affect the spatial pattern of potential contaminants in the NWR. Areas not prone to erosion prior to construction of the POLB ponds now may experience erosion, while other areas are expected to undergo deposition. In general, increased erosion is expected in the east and west main tidal channels of the NWR with increased deposition in the POLB ponds at the ends of those channels.

Chemicals found in food species in concentrations sufficient to potentially produce sublethal effects in the least tern and clapper rail included cadmium, chromium, copper, lead, nickel, zinc, DDE, and PCBs. While spatial patterns of chemical concentrations in sediments and food species were not identical, two general areas in the NWR where levels of some chemicals in sediments and food species were consistently elevated were the northwest and southeast areas of the NWR. The area of concern in the northwest included POLB ponds 1 and 2, and sample locations seaward of those ponds. The area of concern in the southeast included POLB pond 3 and sample locations seaward of that pond. No relationship between the locations of Remedial Investigation sites within or near the NWR and the distribution of contaminants in sediments or food species was apparent from the NWR Study results.

Observed levels of contaminants in food species in the POLB ponds and tidal channels in the NWR do not warrant a concern for immediate remediation. In light of the potential for ongoing erosion and deposition, particularly in the POLB ponds that are intended to provide habitat for the least tern and the clapper rail, monitoring to assess possible further bioaccumulation of chemicals in the northwest and southeast areas of the NWR is recommended. Initially, recommended monitoring would be conducted annually and would include collection and chemical analysis of replicate samples of sediments and food species of the least tern and clapper rail from POLB ponds and nearby sample locations. Timing, location, and the interval for monitoring could be adjusted in response to results of each successive monitoring event.

Responsibility for this monitoring effort should be determined based on conditions included in the Memorandum of Understanding signed by the Navy, USFWS, POLB, CDFG, and the National Marine Fisheries Service (NMFS), which provided guidance for development of the POLB mitigation ponds in the NWR.

The Navy has initiated a Stormwater Monitoring Program to assess quality of surface water runoff into the NWR. The results of this monitoring should be evaluated with respect to results of this monitoring should be evaluated with respect to results of sediment and biota monitoring in the NWR.

The NWR Study Report, in combination with the Stormwater Monitoring Program and continued coordination with the USFWS, satisfies the Navy's responsibility to evaluate effects of the NWS on the NWR.

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1.0 INTRODUCTION

1.1 Authorization

On 20 August 1991, the U.S. Department of the Navy (Navy), Southwest Division, Naval Facilities Engineering Command (SWDIV) issued Contract Task Order (CTO) No. 163 under the Comprehensive Long-term Environmental Action Navy (CLEAN) Program, Contract No. N68711-89-D-9296. CTO 163 authorized the preparation of a National Wildlife Refuge (NWR) Study at Naval Weapons Station (NWS) Seal Beach, California. A modification to CTO 163 authorized initial field work for the study. On 24 September 1992, the Navy issued CTO 237 to complete the remaining tasks identified in the Final Work Plan (SWDIV 1992).

1.2 Background

NWS Seal Beach occupies approximately 5,000 acres adjacent to Anaheim Bay, 26 miles south of the Los Angeles urban center, as shown in Figure 1-1. Within the boundaries of NWS Seal Beach is the 911-acre Seal Beach NWR, which is managed by the U.S. Fish and Wildlife Service (USFWS).

Most of the NWR is occupied by the remaining tidal saltmarsh of the once larger Anaheim Bay system. The tidal saltmarsh in the NWR is composed of three main tidal channels and their tributaries. In this study, these main tidal channels are identified as the east, central, and west arms, as shown in Figure 1-2. The three main tidal channels are separated by tidal flats that are several feet higher in elevation than the adjacent tidal channels. The tidal flats are densely vegetated by a variety of saltmarsh plant species and are inundated by only the highest tides, which occur several times each year. These tidal flats provide nesting habitat for an array of bird species that occupy the NWR, as well as habitat for a variety of invertebrate species on which birds and other vertebrates feed.

In 1990, the Port of Long Beach (POLB) built four ponds at the landward ends of the east and west tidal channels in the NWR (Figure 1-2). The POLB ponds are hydraulically connected to the tidal saltmarsh and are part of the NWR. The ponds were constructed as mitigation for POLB operations offsite and were intended to expand the tidal saltmarsh to provide habitat for endangered species and other biota in the NWR.

Guidance and responsibilities for development and operation of the POLB ponds is addressed in a Memorandum of Understanding signed by POLB, the USFWS, the Navy, California Department of Fish and Game (CDFG) and NMFS.

As part of the Navy's Installation Restoration Program (IRP), an Initial Assessment Study (IAS) (Navy 1985) and a Remedial Investigation (RI) (Navy 1989), identified potential past hazardous waste disposal sites and contaminated areas on NWS Seal Beach that could pose a threat to the biota in the NWR. Additionally, several samples of invertebrates collected at the NWR by the USFWS showed evidence of bioaccumulation of several chemicals (USFWS 1989). Subsequently, an Environmental Impact Statement (EIS) for the NWR was prepared by the USFWS and the Navy (1990) on the Endangered Species Management and Protection Plan. Among other management issues, the EIS

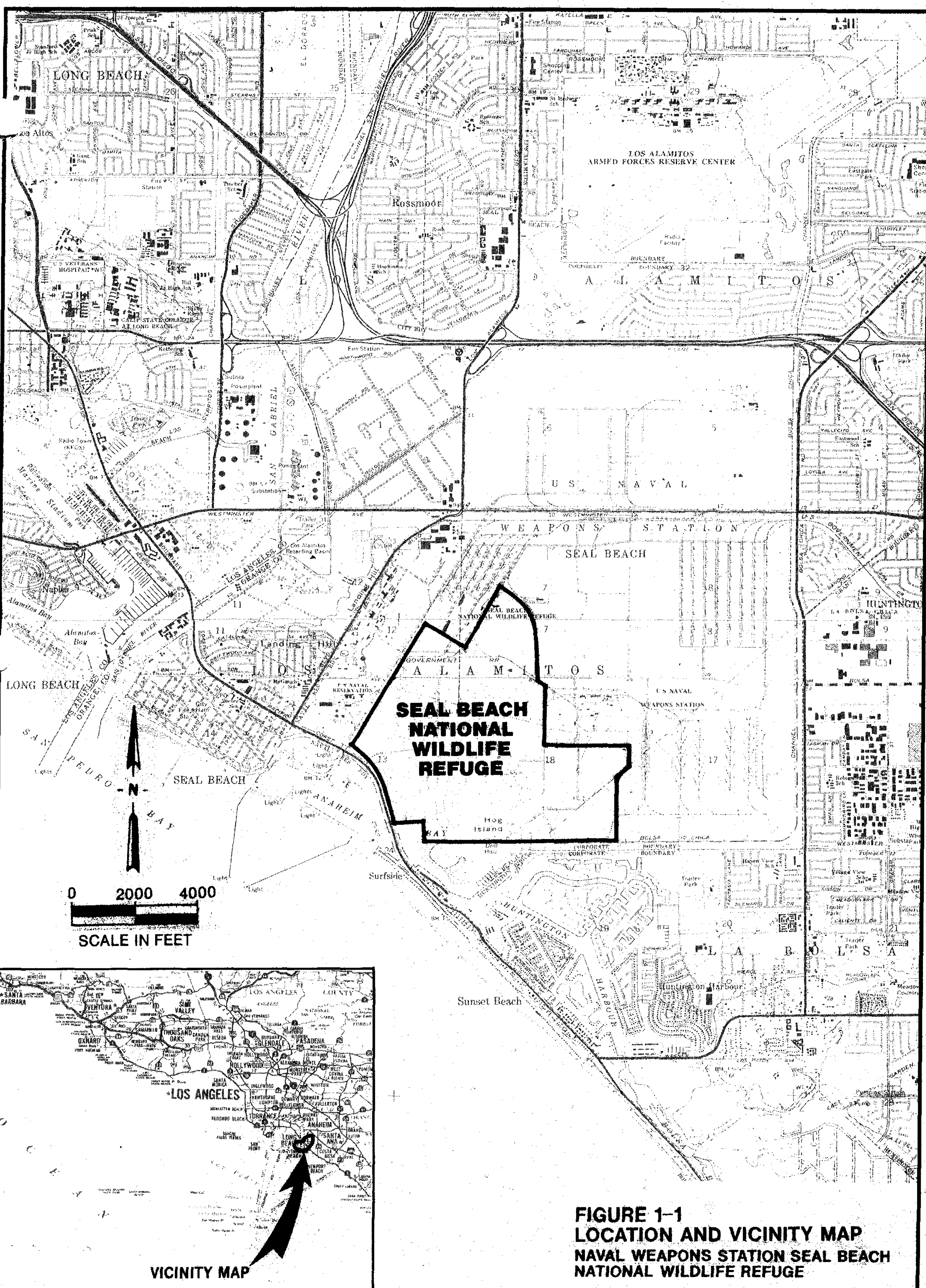

FIGURE 1-1
LOCATION AND VICINITY MAP
NAVAL WEAPONS STATION SEAL BEACH
NATIONAL WILDLIFE REFUGE

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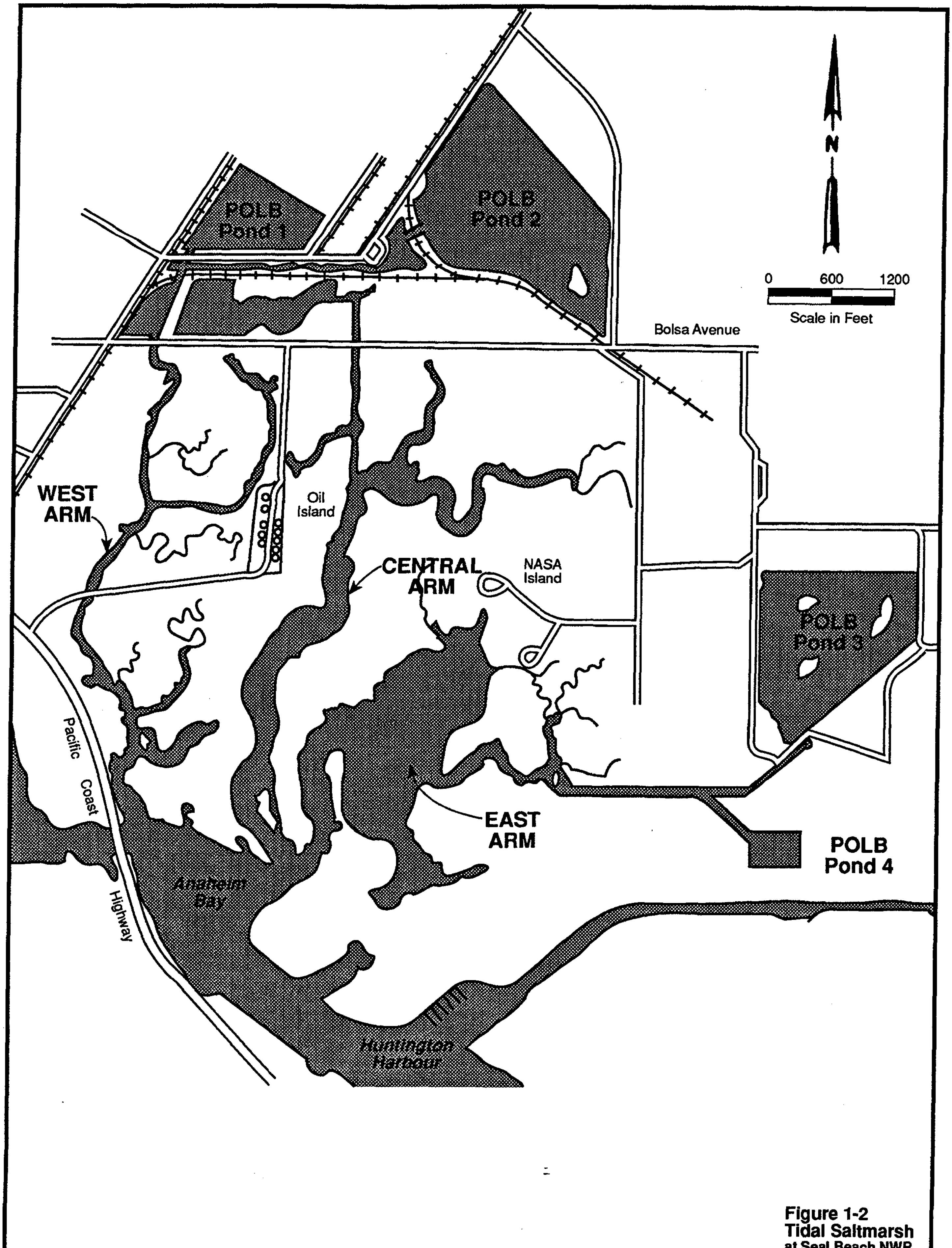

Figure 1-2
Tidal Saltmarsh
at Seal Beach NWR

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addressed the potential for operations at NWS Seal Beach to contribute contaminants to the NWR that could adversely affect the health of the tidal saltmarsh ecosystem and several endangered species that occupy the NWR. The Record of Decision (ROD) for that EIS (dated 27 February 1991) identified, among other actions, the need to assess the impacts of operations at NWS Seal Beach on the biota of the tidal saltmarsh in the NWR. The Seal Beach NWR Study was initiated by the Navy in response to that ROD. The development of the Final Work Plan (SWDIV 1992) for the NWR Study included coordination with and approval by the Navy and the USFWS.

1.3 Purpose of Investigation

Several special-status species occupy the NWR. The California Brown Pelican *(Pelecanus occidentalis californicus)* and American Peregrine Falcon *(Falco peregrinus)*, both listed as endangered by the USFWS and the California Department of Fish and Game (CDFG), occasionally feed at the NWR. The CDFG-listed endangered, USFWS Category 2 candidate (species for which sufficient evidence for listing as threatened or endangered is not yet available), Belding's Savannah Sparrow *(Passerculus sandwichensis beldingi)*, is resident at the edges of the tidal saltmarsh. Additionally, the NWR provides essential breeding habitat for the California Least Tern *(Sterna antillarum browni* [herein referred to as least tern]), and the Light-footed Clapper Rail *(Rallus longirostris levipes* [herein referred to as clapper rail]), both of which are listed as endangered by USFWS and CDFG.

The clapper rail is a permanent resident of the NWR, nesting in saltmarsh vegetation throughout the NWR and obtaining the crabs and snails as its primary food items in the

NWR. Habits of the crabs and snails cause them to be in contact with and/or ingest sediments in the NWR. Contaminated sediments, therefore, could result in bioaccumulation of chemicals in the crabs and snails, and in the clapper rail, which feeds on them.

The least tern occupies and forages for fish in the NWR only during the breeding season from March through late August. Adult least terns forage up to 2 miles away from the nesting colony (USFWS and Navy 1990) on NASA Island in the NWR, but most food for adults and chicks is collected in POLB ponds and tidal channels in the NWR.

While fish consumed by least terns may experience less direct exposure to potentially contaminated sediments, they do bioaccumulate some chemicals as a result of feeding on zooplankton in the water column. This bioaccumulation could, in turn, affect the least tern.

Based on their diets, both the least tern and the clapper rail are high on the food chain in the NWR. This, combined with the fact that the least tern spends up to half of the year in the NWR, and the clapper rail is resident in the NWR, make them most likely of the special-status species in the refuge to experience effects of contaminants, if contaminants occur at levels sufficient to adversely impact the biota in the NWR. The primary focus of the NWR Study, therefore, was on the possible impacts of potential contaminants in the food chain on these two species.

In addition to the NWR Study, which addresses the entire NWR from a broad perspective, a Remedial Investigation (RI) was completed for four sites at the NWS. The

NWS Seal Beach Draft Final Remedial Investigation Report (SWDIV 1994a) documents and summarizes results of the RI conducted at Sites 1 (Wastewater Settling Pond), 7 (Station Landfill), 19 (Building 241 Disposal Pit), and 22 (Oil Island).

As part of the RI, a preliminary Ecological Risk Assessment (EcoRA) was conducted for the four sites. Results of the RI were considered in development of the NWR Study Report and are addressed in Section 5 of the Final Report. Detailed results of the EcoRA are included in the NWS Seal Beach Draft Final Remedial Investigation Report (SWDIV 1994a).

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2.0 GENERAL APPROACH

The initial approach to evaluating the impacts of the operation of NWS Seal Beach on the NWR was the design of a study to assess background levels of hazardous waste-related chemicals in the sediments and biota within the NWR. For the purposes of the NWR Study, the Final Work Plan defined background as those levels of chemicals that would exist in the NWR if it were exposed to existing conditions in the Anaheim Bay watershed without the presence of the NWS Seal Beach. That is, background levels would be those attributable to regionally ubiquitous chemicals and/or those contributed to the NWR from the surrounding Anaheim Bay watershed, with the exception of NWS Seal Beach.

2.1 Phased Study

The most effective means to evaluate background contaminants in the NWR is through a phased study that combines assessing existing chemicals in sediments and biota in the NWR, coupled with an investigation of the physical processes in the tidal saltmarsh that determine sediment transport mechanisms and contaminant patterns. Under ideal conditions, the results of this study would be compared to contaminant levels in sediments and biota at a location that is physically and ecologically comparable to the tidal saltmarsh in the NWR and its watershed, but lacks a military installation that could be a contaminant source similar to NWS Seal Beach. If the locations were strictly comparable, the differences in chemicals and their concentrations would identify those chemicals likely to be attributable to operations of NWS Seal Beach.

Early in the study, a cursory evaluation of tidal saltmarshes in Southern California that could serve as potential comparable sites indicated that there may be no location that would serve as comparable in Southern California. Additionally, because many chemicals already identified as potentially occurring at NWS Seal Beach are known to occur regionally in Southern California, the value of a comparable location to assess the chemicals contributed to the NWR by NWS Seal Beach was considered questionable. The decision was made, therefore, in coordination with the Navy Remedial Project Manager (RPM) and the USFWS, that Phase I of the NWR Study would only include development of screening criteria by which a comparable location could be evaluated, rather than selection and sampling of a comparable location. The primary focus of Phase I of the NWR Study, then, was to assess the existing contaminant levels in sediments and biota in the NWR, analyze the physical processes that influence their distribution, and assess the potential resulting effects on endangered species.

The Phase I investigation was designed to collect sufficient information to assess the following:

- Do elevated levels of chemicals exist in the sediments and/or selected biota in the NWR tidal saltmarsh?

- What are the types and distributions of chemicals in sediments and selected biota in the NWR? Are contamination gradients identifiable?

- o What are the dynamics of contamination problems in the NWR? Do the existing conditions in the NWR result from previous transport of contaminants or is transport ongoing?

- o Did the contamination likely originate from NWS Seal Beach, other sources, or both?

- o What are the potential effects of chemicals of concern (COCs) identified in the NWR on endangered species and other biota?

- o Are data analyses beyond those included in Phase I required to further define the types and extent of contamination or to recommend action?

The amounts and types of data collected and analyses performed in the Phase I study were intended to provide sufficient information to assess whether a contaminant problem exists in the NWR, as well as to design Phase II studies as deemed necessary based on the results of Phase I. This phased approach was considered cost-effective because it would contain the overall cost of the study if no contaminant problems were identified in Phase I, and warranted because there was no evidence that endangered species at the NWR were being affected by contaminants.

2.2 Processes and Components of the Tidal Saltmarsh System

Phase I of the NWR Study included an evaluation of the dynamics of physical processes and the status of physical and biological components of the tidal saltmarsh.

Assessment of the contaminant status of these components and the physical processes that affect them was necessary to evaluate the existing conditions in the NWR and to project how conditions may change and affect the NWR biota.

2.2.1 Physical Processes

An understanding of the physical processes responsible for water circulation and sediment transport in the NWR was required to evaluate the dynamics of the distribution of contaminants in the NWR. The factors that affect physical processes in the tidal saltmarsh in the NWR include:

- Drainage patterns and land use within the watershed that influence the delivery of chemicals to the NWR

- Hydraulic dynamics of the Anaheim Bay system, including the NWR tidal saltmarsh, that influence distribution of sediment (that may carry contaminants), and the resulting sediment transport and erosion/deposition patterns

- Hydrogeological processes that determine potential groundwater contributions of contaminants to the NWR

The information necessary to evaluate these physical processes included:

- o Watershed and land use data (rainfall, topography, soils, drainage patterns, land use, potential contaminant sources)

- o Physical oceanographic data (tidal flux, current velocities, bathymetry, water column profiles, circulation patterns, sediment grain size)

- o Hydrogeological data (well data)

2.2.2 Physical and Biological Components

Animals such as the least tern and clapper rail can be exposed to environmental contaminants through various media and exposure routes. Exposure of birds to contaminants can be measured by analyzing their food, water, air, or body tissues (Ohlendorf, et. al. 1978; Ohlendorf 1993). However, in most ecological risk assessments (EcoRAs) it is possible to assume that one route of exposure is dominant and other routes are negligible (Suter 1993). In the Seal Beach NWR Study, the focus was on the foods of the endangered species because many of the chemicals of potential concern were known to bioaccumulate in plants and animals.

Bioaccumulation is the net accumulation of a chemical by an organism as a result of uptake from all routes of exposure. The food-chain organisms sampled in this study were considered to represent the primary exposure medium for the least tern and clapper rail because they are predominant items in the birds' diets. Contaminants found in the soil, sediment, water, or air would tend to be ingested or inhaled in much smaller quantities than those in the main components of the diet. The food-chain organisms, in turn, would have accumulated contaminants through an integration of their exposures to abiotic media (e.g., soil/sediment, water, or air) to which they were exposed, along with their dietary exposures.

For example, the snails feed on algae, detritus, whereas the crabs also eat smaller invertebrates. The fish sampled in the NWR study feed on various small plants (phytoplankton) and animals (zooplankton, insects, etc.) that may have accumulated chemicals through ingestion or direct uptake from the water or sediment.

Information collected to evaluate the physical and biological components of the NWR for Phase I included:

- o Assessment of chemical concentrations in sediments in the NWR because contact with food-chain species could cause bioaccumulation of chemicals

- o Assessment of chemical concentrations in the food-chain species (invertebrates and fish) most frequently consumed by the two species of greatest concern in the NWR, the clapper rail and the least tern

- o At the request of the USFWS, assessment of chemical concentrations in benthic invertebrates to evaluate potential effects on other aquatic bird species that feed in the NWR

- o At the request of the USFWS, Microtox® bioassays to provide a general measure of potential contamination throughout the NWR sediments

The chemicals selected for analysis were those that were expected to occur as a result of NWS Seal Beach activities for which information on wildlife toxicology was available. Other chemicals (e.g., antimony) were not included because interpretive information is unavailable. In general, the emphasis was on inorganic and organic chemicals that could be expected to have adverse effects on species of concern, if the chemicals occurred in the food chain at elevated concentrations. Potential COCs that were targeted for analysis are addressed in Subsection 3.5.2.

2.2.3 Other Studies

While most of the data sets required to evaluate the impacts of NWS Seal Beach operations on the endangered species in the NWR were necessarily collected directly for the study, information from previous studies, existing databases, and studies being completed under the Navy's IRP was identified and incorporated into the NWR Study wherever appropriate.

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3.0 METHODS

This section summarizes the methods by which information on physical processes and physical and biological components of the NWR was collected and analyzed to assess the impacts of potential contaminants resulting from operations at NWS Seal Beach on biota of the NWR. Additional detail on methods may be found in supporting Technical Memoranda included in this report as Appendices A (Watershed and Land Use Characterization), B (Sediment Transport Evaluation), C (Sediment Chemistry Evaluation), and D (Environmental Contaminant Evaluation).

3.1 Watershed and Land Use Characterization

The watershed surrounding the NWR was characterized to identify surface drainage patterns and potential sources of contamination to the NWR other than the NWS Seal Beach, and to develop criteria for selection of a comparable site for potential Phase II study.

Characterization of the watershed included several subtasks: collection of available data on the size, topography, soils, hydrology, land use, and water quality in the surrounding watershed; incorporation of the collected data onto map overlays; and synthesis of this information to summarize watershed characteristics.

3.1.1 Data Collection

Data describing the topography, hydrology, and land use in the watershed were collected from a variety of federal, state, and local agencies, as well as through site visits and independent sources. Hydrologic and surface runoff data were obtained from the Orange County Environmental Management Agency (OCEMA); precipitation records were obtained from the California Department of Water Resources (CDWR); soil types in the watershed were taken from the Soil Conservation Service (SCS) soils maps; land use data were obtained from the CDWR, Orange County, municipalities in the watershed and from recent aerial photographs; and water quality data for a number of sampling stations within the watershed were obtained from the U.S. Environmental Protection Agency's (EPA's) STORET System database.

3.1.2 Overlay Mapping

A base map for the watershed was prepared using U.S. Geological Survey 7-1/2 minute quadrangle maps. Watershed and subbasin boundaries, drainage locations, soils distributions, surface water discharge points, and sampling stations for EPA STORET data were located on mylar overlays on the base map. Estimates of the size of the watershed and the Anaheim Bay system were completed using a planimeter.

3.1.3 Data Analysis

Overlay maps and land use information were used to identify the most important attributes of the watershed potentially affecting background contaminant levels and to develop criteria for identifying a comparable location.

3.2 Physical Oceanography Evaluation

The primary objective of the physical oceanography evaluation for the NWR Study was assessment of sediment transport mechanisms and sediment erosion/deposition analysis in the NWR to provide an understanding of the dynamics of potential contaminant movement within the NWR. This understanding provides a framework for evaluation of chemical analyses resulting from sediment and biological sampling efforts by explaining the processes by which potentially contaminated sediments may be transported into and throughout the NWR and the Anaheim Bay system. Information required for this evaluation included:

- Physical oceanographic data collected through existing sources, as well as through field data collection, to evaluate the physical processes of potential importance for contaminant transport in the NWR and the surrounding Anaheim Bay system

- Use of the physical oceanographic data to develop a computer model for evaluating the hydrodynamics of the tidal saltmarsh in the NWR

- o Assessment of the sediment transport potential within the NWR based on the results of the computer modeling

3.2.1 Data Collection

Data collected to support the physical oceanography evaluation included water surface elevations (tidal data), bathymetry and dimensions of tidal channels, and water column profile data at selected locations in the NWR. Data were collected for each of the three main tidal channels: the west, central, and east arms (Figure 1-2). These data were used to develop and calibrate the computer model that was used to estimate current velocities and sediment transport potential in the NWR. Current and sediment transport potential are critical to evaluating the transport of potential contaminants in the NWR tidal saltmarsh.

Water level data. Water surface elevation data, as measured by tidal propagation (the degree to which water level changes from ocean tides are communicated landward through tidal channels in the saltmarsh), were collected using four Flo-Tote water level gauges at four stations. Three gauges were located near the landward ends of the main tidal channels in the NWR, as shown in Figure 3-1. To characterize ocean tides, one gauge was located at a Navy pier in Anaheim Bay, approximately 2,000 feet west of the Pacific Coast Highway Bridge (not shown on Figure 3-1). Gauges were deployed from 2 December 1992 through 4 January 1993 and were set to take water surface level readings every 10 minutes for a 30-second sampling interval. Additionally,

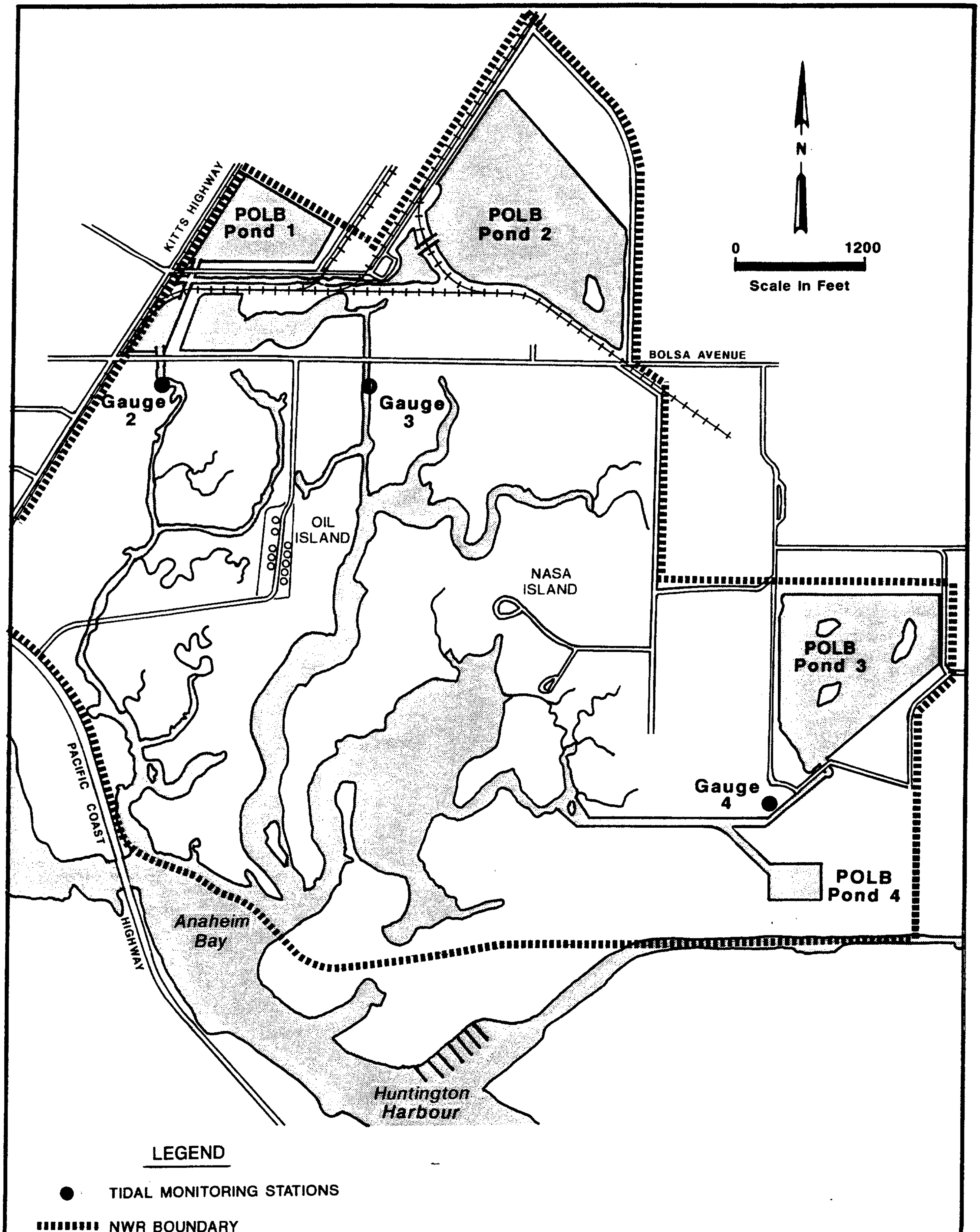

FIGURE 3-1
TIDAL MONITORING STATIONS
AT SEAL BEACH NWR

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tide data collected at Newport Beach, approximately 10 miles from Anaheim Bay, were obtained from National Oceanic and Atmospheric Administration (NOAA) for the month of December 1992. Newport Beach data were substituted for those collected by the tidal gauge installed at the Navy pier to characterize ocean tides when it was discovered that the data recorded by the Anaheim Bay gauge were unusable because of gauge malfunction. The Newport Beach data are comparable to the Anaheim Bay data for use in this context.

Bathymetry data. Bathymetry data (water depth) were collected on 1 November 1992 along selected transects (see Figures 2 through 4 in Appendix B) in the NWR. Continuous traces of the depths along each transect were recorded using a King Marine Model 1350 fathometer. A marked pole was also used as a backup for the fathometer and to take spot readings in areas too shallow for fathometer operation or where eel grass growing in the channels interfered with readings. The placement of the transects in the channels and the spot measurements was conducted using landmarks and channel configurations.

Water column profile. Water temperature and salinity were measured on 1 November 1992 throughout the water column at selected locations. At each location, readings were taken near the surface and just off of the bottom of the channel using a YSI CT meter. Current velocity measurements were taken on 13 November 1992 using a Price AA current meter at locations near the mouths of each of the three main arms of the NWR. Measurements at each location were taken approximately 1 foot below the water surface, 1 foot above the channel bottom, and at mid-depth. These data were used to characterize the flow in the tidal saltmarsh. For example, if surface and bottom measurements were different, it could indicate a stratified, two-layer flow system, requiring the use of a different model than if the measurements showed the water column to be well-mixed. Current velocity measurements were also included in choice of the model.

3.2.2 Computer Modeling

Circulation model description. Using the data described above, a circulation computer model developed by CH2M HILL, based on a finite difference numerical scheme presented by Koutitas (1988), was used to estimate current velocities in the tidal saltmarsh and to provide the basis for sediment transport evaluation. The model is a 1-Dimensional (1-D) model (flow in the direction of the channel axis only) modified to model flow in tributary branches, as well as flow through the main channels of the tidal saltmarsh. The model solves depth-averaged continuity and momentum equations to calculate the response of the channels to given water level (tidal) variations. Model output of average current velocities at selected locations in the tidal saltmarsh provides the basis for sediment transport evaluation.

Equation structure and details of model function, including calibration of the model and sensitivity analysis, are discussed in Appendix B. A listing of the program is provided in Attachment 2 of Appendix B.

The use of the model for the NWR is based on the following major assumptions:

- 1-D Flow: The 1-D case assumes that the important variations in hydrodynamic and hydrographic parameters in the NWR are along the axis of the channel rather than in the vertical and cross-channel directions. Flow rates are taken as depth and cross-channel average values.

- Unstratified Flow: The model assumes that there is no significant difference between near-surface and near-bottom values of temperature and salinity for dry-weather periods. This assumption was confirmed by measurements taken during field data collection.

- Bulk Formulation of Bottom Friction: Bottom friction is expressed as a nonlinear function of current speed with a constant friction coefficient. Model calibration adjusts the friction coefficient for the system under consideration.

Model description. The CH2M HILL model described above is capable of modeling a single 1-D main channel with a series of 1-D channels feeding into the main channel. Because the NWR contains three separate main tidal channels (west, central, and east arms), three separate models were developed representing existing conditions (including POLB mitigation ponds) in each of the three main arms of the tidal saltmarsh. Two additional models were run for the east and west arms representing conditions prior to the construction of the POLB ponds to assess possible hydraulic effects on the tidal saltmarsh associated with their installation.

Calibration and sensitivity. Calibration of the models was required to account for site-specific characteristics of the NWR tidal saltmarsh. This was accomplished primarily by adjusting the friction coefficient until the hydraulic response of the modeled system matched the response measured in the field. The models representing the existing conditions in the tidal saltmarsh were calibrated both against observed currents from field measurements taken on 13 November 1992 and water level data from the tidal data collected during December 1992. These calibrations provided friction coefficient values for each of the arms of the tidal saltmarsh that were then used for the model runs.

Model runs. The models were run for a tidal range at the mouth of the tidal saltmarsh of 8 feet with a 14-hour period, corresponding to the order of extreme events based on a review of the tidal predictions for Los Angeles, California in the National Oceanic Service (NOS) tide tables (NOS 1993). These tides were assumed to be sinusoidal and were run for a sufficient number of cycles so that any transients resulting from start-up of the model would damp out. The maximum current velocities were extracted from the results of each model for use in the sediment transport evaluation.

3.2.3 Sediment Transport Evaluation

Transport of sediment in the NWR results from shear stresses acting on the bed material from fluid flow over the bed. As the velocity of flow over the bed increases, a threshold level may eventually be reached. This threshold level is defined as the conditions at which sediment motion will be initiated.

Various factors, such as sediment and fluid density, grain size, and shape and profile of the channel bottom, influence threshold velocity. Hjulström developed a simplified sediment threshold criterion to predict erosion, transport, and deposition of various size sediment grains based on average flow velocities (Graf, 1971) (see the Hjulström diagram, Appendix B, Figure 9). This criterion indicates that uncohesive, fine, and medium sand are most easily eroded, but that cohesion tends to bind smaller clay and silt size particles together to resist erosive forces. Once mobilized, however, the smaller sediments will stay in motion under the influence of smaller current velocities. In other words, sand-sized particles would be most easily mobilized as the current velocity increases and the first to settle out as the currents decrease.

An empirical relation for the threshold of sand-sized material was presented by Costa and Issacs (1977) and has been applied to tidal flows by Stauble et al. (1987, 1988), Bhogal (1989), and Bhogal and Costa (1989). This criterion relates the critical velocity, depth of flow, and sand grain size and is given by:

$$V_c = K(D)^a(g)^b \qquad \text{Eqn (1)}$$

where:

V_c = the critical mean velocity (ft/sec)

D = the depth of flow (ft)

g = the median grain size

K = 1.168

a = 0.1

b = 0.4

K, a, and b are empirical constants determined from field and flume data. For the NWR Study, this relationship was applied for a range of grain sizes from about 0.1 to 0.9 millimeters (mm).

Deposition/Erosion Analysis. The deposition/erosion analysis for the NWR combined information on maximum current velocities derived from model runs, sediment grain-size results from sediment analyses, and thresholds for mobilization of sand-sized materials to predict patterns of sediment erosion and deposition, thus, potential contaminants movement in the NWR tidal saltmarsh.

The following approach was taken for evaluating the erosion/deposition tendencies for the tidal saltmarsh:

- The threshold current velocities for the silt and sand-sized grains were assessed.
- The current velocities that result in deposition of the above grain sizes were evaluated.
- Current velocities required for erosion and deposition were compared with the maximum current velocities calculated by the circulation model presented above.
- Areas of the tidal saltmarsh that are prone to erosion or deposition were identified based on the above evaluations.

3.3 Hydrogeological Evaluation

The potential for contaminants to be introduced to the NWR through groundwater was evaluated by assessing the direction of groundwater movement. Groundwater level measurements were made at four wells during field work to collect physical oceanographic data. Additionally, information on local hydrogeologic conditions was collected during RI field activities. This information was evaluated to assess the predominant direction of groundwater movement and the potential for groundwater to contribute contaminants to the NWR.

3.4 Sediment Chemical Evaluation

The purpose of sediment chemical evaluation in the NWR was to assess the existing levels and distribution of chemicals in sediments and to identify gradients in chemical concentrations. Combined with an understanding of physical transport mechanisms, this information is important to evaluate potential sources of contamination in the NWR.

3.4.1 Sample Collection

Sediment samples were collected on 24 through 26 October 1992 from 22 locations in the NWR and 1 location at the mouth of Huntington Harbour near the southwest boundary of the NWR, as shown in Figure 3-2. Samples were collected in tidal channels immediately adjacent to the sample locations identified for collection of invertebrates on the tidal flat. An 11-foot-long inflatable boat was used to access most of the sample locations, and sediment was collected from the boat using a Ponar dredge or a shovel. At each sample location, the time of collection, sample number, code for required analyses, stratification of sediment, texture, organic material, and other physical characteristics were noted in a field notebook. Chain-of-custody records were prepared daily for all samples collected.

At each sample location, a minimum of 200 grams (g) of sediment was collected in a whirl-pak® container for total metals analysis, a minimum of 400 g was collected in a chemically cleaned and certified I-Chem bottle for analysis of pesticides, polychlorinated biphenyls (PCBs), and polycyclic

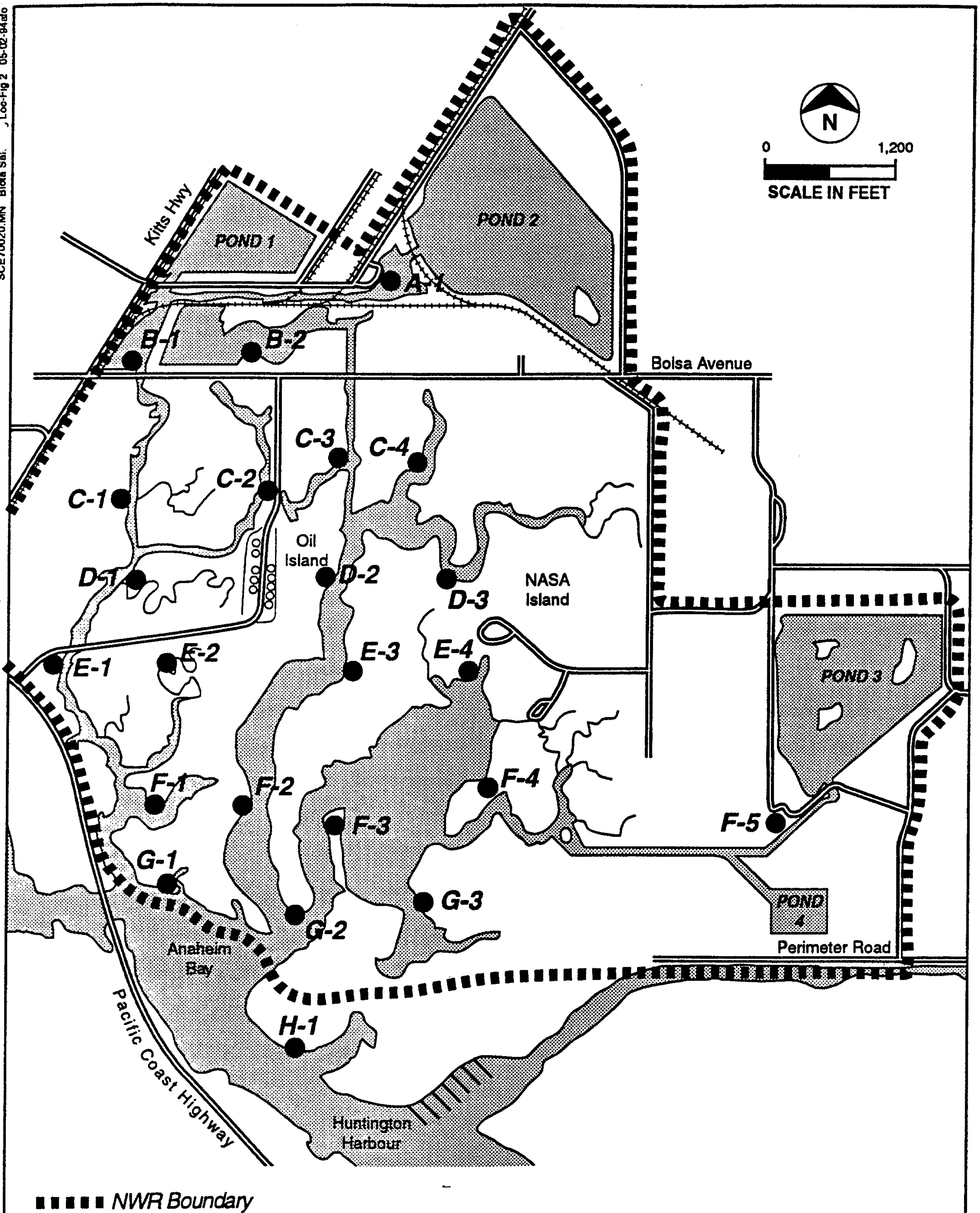

FIGURE 3-2
SEDIMENT AND BIOTA SAMPLE LOCATIONS
AT SEAL BEACH NWR

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aromatic hydrocarbons (PAHs), and a minimum of 100 g was collected in each of two I-Chem bottles for total organic carbon analysis and acid volatile sulfide analysis.

3.4.2 Sample Analysis

From among the 23 sample locations, two split samples were obtained for each type of analysis. Two field duplicates for each type of analysis were obtained from sample locations not used for split samples. Two samples with sufficient volumes of sediment were designated for use for matrix-spike duplicates (MSDs).

Samples were initially stored on ice, then frozen while awaiting permission from the USFWS to ship them to the USFWS contract laboratory, Geochemical and Environmental Research Group (GERG), at Texas A&M University. The GERG was contracted through an Interagency Agreement (IAG) between the USFWS and the Navy specifically to complete sediment and biological analyses for this Seal Beach NWR Study.

Analyses were conducted by GERG following NOAA Status and Trends methods as described in Appendix B of the Final Work Plan (SWDIV, 1992). The GERG uses Contact-Required Detection Limits (CRDL). The CRDL varies somewhat because of sample sizes and interference. The GERG performs annual computations of their method detection limit as required by 40 CFR Part 136, Appendix B. Arsenic, barium, cadmium, chromium, copper, nickel, selenium, silver, and zinc were analyzed by inductively coupled plasma (ICP) emission spectroscopy following sample digestion according to Standard Operating Procedure (SOP)-8905. Lead was analyzed by graphite furnace atomic absorption (AA) spectroscopy and mercury by cold vapor reduction AA according to SOP-8905. Target detection limits were as follows: 4 milligrams per kilogram (mg/kg) lead; 3 mg/kg silver; 1 mg/kg barium; 0.6 mg/kg copper; 0.5 mg/kg arsenic, chromium, nickel, and selenium; 0.2 mg/kg zinc; and 0.1 mg/kg cadmium and mercury. For PAHs, cleanup and extraction was according to SOP-ST04 and analysis was by gas chromatography/mass spectrometry (GC/MS) according to SOP-8905. For pesticides and PCBs, extraction and cleanup were by SOP-9015 and analysis by SOP-ST04. Target detection limits were 5 nanograms per gram (ng/g) (or 0.005 mg/kg) for individual PAHs, and 2 ng/g (or 0.002 mg/kg) for individual pesticides and PCBs when levels of detection were low; in samples with high concentrations, the target detection limits were 60 times those values.

Quality assurance/quality control (QA/QC) for the chemical analyses was provided by the USFWS Patuxent Analytical Control Facility (PACF) in accordance with that agency's existing contract with GERG, as described in Appendix B of the Final Work Plan (SWDIV 1992). Method blanks were run with every 20 samples or with every sample set, whichever was more frequent. Blank levels were acceptable if they were no more than three times the method detection limit (MDL). MS/MSD samples were run at the same frequency as method blanks with the spiking level between 3 and 10 times the MDL. Surrogate materials were added (spiked) to each sample (including QC samples) at levels between 3 and 10 times the MDL. In addition, standard reference materials were analyzed at a frequency of one per sample batch (or 20 samples). Criteria for acceptance of analytical results are discussed in Appendix B of the Final Work Plan.

3.4.3 Evaluation of Sediment Chemical Analyses

Results of analyses were evaluated based on the most current standards presented in a 1993 report titled *Criteria to Rank Toxic Hot Spots in Enclosed Bays and Estuaries of California* provided by the State of California, State Water Resources Control Board, Division of Water Quality, which includes sediment screening levels developed by the NOAA (Long and Morgan 1990) and by the State of Florida (1993). Concentration of chemicals in sediment was the only one of the three ranking parameters that was applied in the toxic hot spot evaluation. This was done for evaluation purposes only. In addition, sediment chemical values were compared with ERM and ERL values of Long and Morgan (1990).

3.5 Biological Chemical Evaluation

The purpose of biological chemical evaluation in the NWR was to identify chemical levels in invertebrate and fish species ingested by the clapper rail and the least tern, as well as by other bird species that forage in the NWR. Invertebrate species eaten by the clapper rail (snails, crabs, and benthic species) and fish species eaten by the least tern were chosen for sampling because these food species potentially bioaccumulate chemicals, making the birds more likely to be exposed to harmful levels of chemicals in food than in other media (air, water, or sediment). Sampling events were scheduled for the breeding season during which exposure to chemicals is of greatest concern because chemical exposure during egg-laying could subsequently affect developing embryos in the eggs and because adult birds feed chicks food items collected in the NWR.

3.5.1 Sample Collection

Samples of invertebrates and fish were collected by Jacobs Team biologists from CH2M HILL (with assistance on some occasions from Navy, USFWS, and Department of Toxic Substances Control [DTSC] personnel). Invertebrates were collected at 22 sample locations in the NWR and 1 sample location at the mouth of Huntington Harbour, near the southern boundary of the NWR (Figure 3-2). Table 3-1 provides a summary of sampling events and species collected during the study. Fish were collected in the four POLB ponds and at four locations in tidal channels in the NWR. Fish collection occurred twice during the breeding season in 1992 and three times during the breeding season in 1993 (see Resampling subsection later in 3.5.1) so that all size classes of fish fed to least tern chicks would be analyzed for contaminants.

Crabs and snails were collected once during the 1992 breeding season and then were resampled over two sampling events following the 1992 breeding season in October 1992 and during the 1993 breeding season (see

Table 3-1
Summary of Sampling Times and
Species Collected During the Seal Beach NWR Study

	Year and Month					
	1992			1993		
Species	**May**	**June**	**October**	**May**	**June**	**July**
Deepbody anchovy (*Anchoa compressa*)			X	X	X	X
Northern anchovy (*Engraulis mordax*)	X	X			X	X
California killifish (*Fundulus parvipinnis*)			X	X	X	X
Queenfish (*Seriphus politus*)			X		X	
Topsmelt (*Atherinops affinis*)	X	X	X	X	X	X
Goby (Gobiidae)				X	X	X
Diamond turbot (*Hypsopsetta guttulata*)					X	
Horned snail (*Certhidea californica*)		X	X			
Saltmarsh snail (*Melampus olivaceous*)		X	X	X	X	
Striped shore crab (*Pachygrapsus crassipes*)		X	X	X		
Clam			X			
Ghost shrimp (*Callianassa affinis*)				X	X	
Polychaete worms (*Nereis* sp.)				X		
Filamentous algae					X	

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Resampling subsection later in 3.5.1). An inflatable boat was used to gain access to most of the sample locations.

Sampling was coordinated with the USFWS to ensure that disturbance to nesting birds (especially the clapper rails that nest throughout the NWR) would be minimized. Fish sampling was also coordinated with investigators monitoring the POLB mitigation ponds to minimize impacts of the NWR sampling on their ongoing monitoring of biotic colonization of the ponds.

Samples of all species for organic contaminants analyses were placed in 250 milliliter (ml) or 500 ml chemically cleaned and certified I-Chem glass jars. Samples for inorganic analyses were placed in whirl-pak® plastic bags. Field-collected duplicate samples were taken for both inorganic and organic analyses at sample locations where organisms were found in adequate abundance. At each sample location, the date, sample number, species, and code for the associated analyses were recorded in a field notebook. Chain-of-custody records were prepared daily.

As was the case with sediment samples, arrangements for completion of contaminant analyses on biological samples were included in an IAG between the Navy and the USFWS. The IAG could not be completed before the 1992 field season began, therefore, efforts to finalize that agreement proceeded as samples were collected. Samples could not be forwarded to the USFWS contract laboratory for analysis until the IAG was completed. Therefore, following their collection and before completion of the IAG, all samples were stored in a rented freezer in Building 68 at the NWS Seal Beach, as agreed to by all parties.

Crabs and snails. Striped shore crabs, saltmarsh snails, and horned snails were collected at each of the 23 sample locations shown in Figure 3-2. Snails and crabs were collected by hand along the edges of tidal channels and on tidal flats between tidal channels. Animals were rinsed in ambient water from the tidal saltmarsh before being placed into sample containers and frozen for storage. Algae or mud not removed during this rinsing remained on the samples to represent the condition of the food items as they would be ingested by foraging birds. To provide sufficient biomass for contaminant analyses (15 grams minimum), individuals of a single species were combined to create composite samples.

Benthic Invertebrates. The USFWS requested the collection and analysis of benthic infauna samples to evaluate the potential contaminants in the food items of birds other than the clapper rail and least tern that forage in the NWR. Benthic invertebrates (polychaetes and mollusks) were collected at sample locations where they were sufficiently abundant to obtain adequate biomass for analysis (minimum 15 g) using an air-lift dredge and screen (Pearson et al. 1973) or hand trowels.

Fish. Fish (primarily topsmelt and deepbody anchovy) were sampled in the four POLB mitigation ponds located within the NWR (see Figure 3-2). In addition, during each sampling event, fish were collected at four locations in

NWR tidal channels where least terns were observed feeding and where it was possible to sample with the available equipment. Accessibility to areas for fish sampling was affected by the tide level, thus, sample locations for fish were not always consistent between sampling events.

Fish were captured with a 4-foot-deep, 100-foot-long, 1/4-inch mesh, beach seine. Fish were sorted by species and species with adequate biomass for chemical analysis were rinsed with ambient water and frozen as composite samples for analysis. Individuals that were too large to be considered food items for the least terns or species with insufficient biomass to comprise a sample for analysis were noted and returned to the pond or tidal channel. Fish species taken in the POLB ponds and in tidal channel locations were identified and recorded in the field notebook, regardless of whether they were collected for analyses.

Microtox® testing. USFWS conducted bioassay testing of sediments from each of the 23 sample locations using a Microtox® test, which measures toxicity to marine bacteria and is sensitive to a broad array of chemicals. When sediment samples were collected from 24 to 26 October 1992 for chemical analysis, a subsample of the homogenized sediment was taken for the bioassay. This sample was stored on ice in the field and then transported to the USFWS office in Carlsbad, California, where the bioassays were conducted within 24 hours of collection.

Resampling. On 12 August 1992, a Jacobs Team biologist discovered that power had been cut off to the portion of Building 68 at NWS Seal Beach in which the frozen samples were stored. The duration of the power outage was sufficient for the specimens (which included fish collected during the May 1992 sampling event, and fish, crabs, and snails collected during the June 1992 sampling event) that were stored there to thaw and decompose. Some of the whirl-pak® containers ruptured, causing potential cross-contamination and rendering these samples unusable.

Eighteen of the thawed but intact samples were salvaged and refrozen for analysis; the others were discarded. Those salvaged (four crab samples, four horned snails, four saltmarsh snails, four topsmelt, and two anchovies) were selected to represent various areas within the NWR for comparison with samples that would be recollected.

Following the discovery in August that all samples in the freezer had thawed, the Jacobs Team consulted the Navy (Jeff Kidwell), USFWS (Steve Goodbred and Leonard LeCaptain), Jacobs Team Technical Reviewers (Mike Concannon and Steve Cox), and the USFWS contract laboratory (Terry Wade) to determine whether the salvaged samples would be useful for analysis and, if not, the best plan for obtaining replacement samples. The conclusions of this evaluation were:

- The 18 salvaged samples should undergo contaminants analysis. Analyses for inorganic and organic chemicals would be performed on samples collected in I-Chem bottles (originally intended for organic chemical analyses only) because Whirl-paks® containing samples for inorganic chemical analyses ruptured during the thawing process.

- o Crabs and snails should be collected to replace the lost samples (but the timing of this collection need not be constrained by the breeding season because the invertebrates are consumed year-round by clapper rails at the NWR).

- o A third 1992 collection of fish should be conducted as soon as possible (because the tern breeding season was expected to end by mid-August).

- o Replacement fish collection for the tern breeding season should be scheduled for May, June, and July 1993.

The Jacobs Team did not receive notice to proceed with the resampling until late September 1992. Therefore, resampling for invertebrates and a limited fish sampling was conducted in October 1992. Invertebrate species that could not be recollected at several sample locations in October 1992 were recollected in May or June 1993. Fish were recollected in May, June, and July 1993.

Tern eggs. Twenty-three least tern eggs that failed to hatch in the breeding colony at NASA Island in the NWR were collected by the USFWS in 1991 and 1993 and were analyzed in eleven samples for inorganic and organic contaminants as part of the NWR Study. These samples included five single eggs and six composites composed of three eggs each to provide sufficient biomass for analysis. After collection, the eggs were stored in a refrigerator until processing in the USFWS laboratory at Carlsbad, California. Eggs were measured and then cut open with a clean scalpel around the middle. Contents were placed into I-Chem (chemically cleaned) jars and frozen. Shells were cleaned of loose debris with tap water and allowed to dry for eggshell thickness measurements (being performed by USFWS and not reported here).

3.5.2 Analytical Methods

Invertebrates, fish, and least tern eggs. Samples of invertebrates (including exoskeletons and shells) and fish were analyzed as whole-body composited samples for inorganic and organic contaminants listed in Table 3-2 by the GERG at Texas A&M University, College Station. Whole-body analysis allowed evaluation of the organism as ingested by the birds, including algae or sediments adhering to shells, and sediment present in the gut.

The GERG was under contract to USFWS to perform analyses of sediment and biological samples for the NWR Study. The choice of a USFWS contract laboratory to conduct the analyses was made because of the role of the USFWS in managing the NWR, and to help ensure the acceptability of the data. The GERG was selected from among the USFWS-contracted laboratories because it was the only laboratory that could perform the full suite of analyses required.

Table 3-2
Method Detection Limits for Chemicals in Biological Samples

Sheet 1 of 4

Chemical	Method Detection Limit
Inorganics (mg/kg, dry weight)	
Aluminum	11.1
Arsenic	0.5
Barium	0.2
Boron	0.7
Cadmium	0.1
Chromium	4.0
Copper	0.8
Iron	1.4
Lead	0.5
Magnesium	12.8
Manganese	0.3
Mercury	0.1
Molybdenum	1.7
Nickel	2.6
Selenium	0.5
Silver	0.3
Strontium	0.1
Vanadium	3.6
Zinc	1.2
Organics (mg/kg, wet weight)	
Acenaphthalene	0.02
Acenaphthene	0.01 or 0.02
Acenaphthylene	0.01 or 0.02
Aldrin	0.01 or 0.02
Anthracene	0.01 or 0.02

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Table 3-2
Method Detection Limits for Chemicals in Biological Samples

Sheet 2 of 4

Chemical	Method Detection Limit
1,2-Benzanthracene	0.02
Benzo(a)anthracene	0.01 or 0.02
Benzo(a)pyrene	0.01 or 0.02
Benzo(b)fluoranthene	0.01 or 0.02
Benzo(e)pyrene	0.01 or 0.02
Benzo(g,h,i)perylene	0.01 or 0.02
Benzo(k)fluoranthene	0.01 or 0.02
alpha-BHC	0.01 or 0.02
beta-BHC	0.01 or 0.02
delta-BHC	0.01 or 0.02
gamma-BHC (Lindane)	0.01 or 0.02
1,1-Biphenyl	0.01 or 0.02
Biphenyl	0.02
C1-Chrysenes	0.01 or 0.02
C2-Chrysenes	0.01 or 0.02
C3-Chrysenes	0.01 or 0.02
C4-Chrysenes	0.01 or 0.02
alpha-Chlordane	0.01 or 0.02
gamma-Chlordane	0.01 or 0.02
Chrysene	0.01 or 0.02
4,4'-DDD	0.01 or 0.02
4,4'-DDE	0.01 or 0.02
4,4'-DDT	0.01 or 0.02
1,2,5,6-Dibenzanthracene	0.02
Dibenzo(a,h)anthracene	0.01 or 0.02
C1-Dibenzothiophenes	0.01 or 0.02

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Table 3-2
Method Detection Limits for Chemicals in Biological Samples

Sheet 3 of 4

Chemical	Method Detection Limit
C2-Dibenzothiophenes	0.01 or 0.02
C3-Dibenzothiophenes	0.01 or 0.02
Dibenzothiophene	0.01 or 0.02
Dieldrin	0.01 or 0.02
2,6-Dimethylnaphthalene	0.01 or 0.02
Endrin	0.01 or 0.02
C1-Fluoranthenes and Pyrenes	0.01 or 0.02
C1-Fluorenes	0.01 or 0.02
C2-Fluorenes	0.01 or 0.02
C3-Fluorenes	0.01 or 0.02
Fluoranthene	0.01 or 0.02
Fluorene	0.01 or 0.02
HCB	0.02
Heptachlor	0.01 or 0.02
Heptachlor Epoxide	0.01 or 0.02
Hexachlorobenzene	0.01 or 0.02
Indeno(1,2,3-CD)pyrene	0.01 or 0.02
1-Methylphenanthrene	0.01 or 0.02
1-Methylnaphthalene	0.01 or 0.02
2-Methylnaphthalene	0.01 or 0.02
Mirex	0.01 or 0.02
C1-Naphthalenes	0.01 or 0.02
C2-Naphthalenes	0.01 or 0.02
C3-Naphthalenes	0.01 or 0.02
C4-Naphthalenes	0.01 or 0.02
Naphthalene	0.01 or 0.02

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Table 3-2
Method Detection Limits for Chemicals in Biological Samples

Sheet 4 of 4

Chemical	Method Detection Limit
cis-Nonachlor	0.01 or 0.02
trans-Nonachlor	0.01 or 0.02
o,p'-DDD	0.01 or 0.02
o,p'-DDE	0.01 or 0.02
o,p'-DDT	0.01 or 0.02
Oxychlordane	0.01 or 0.02
C1-Phenanthrenes and Anthracenes	0.01 or 0.02
C2-Phenanthrenes and Anthracenes	0.01 or 0.02
C3-Phenanthrenes and Anthracenes	0.01 or 0.02
C4-Phenanthrenes and Anthracenes	0.01 or 0.02
PCB-1254	0.01 or 0.02
PCB-1260	0.01 or 0.02
PCB-TOTAL	0.01 or 0.02
Perylene	0.01 or 0.02
Phenanthrene	0.01 or 0.02
Pyrene	0.01 or 0.02
Toxaphene	0.01 or 0.02
1,6,7-Trimethyl-Naphthalene	0.01 or 0.02

Sample analyses were completed by GERG in 1992 and 1993 during which time method detection limits for some chemicals changed. Method detection limits for those chemicals, therefore, are shown as "0.01 or 0.02."

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Method detection limits used were those specified by the USFWS and are based on NOAA Quality Assurance/Quality Control (QA/QC) criteria. Analyses for organic contaminants were conducted following the NOAA Status and Trends methods described in Appendix B of the Final Work Plan (SWDIV 1992). Arsenic, barium, cadmium, chromium, copper, nickel, selenium, silver, and zinc were analyzed by ICP emission spectroscopy following sample digestion according to SOP-8905. Lead was analyzed by graphite furnace AA spectroscopy and mercury by cold vapor reduction AA according to SOP-8905. Target detection limits were as follows: 4 mg/kg lead; 3 mg/kg silver; 1 mg/kg barium; 0.6 mg/kg copper; 0.5 mg/kg arsenic, chromium, nickel, and selenium; 0.2 mg/kg zinc; and 0.1 mg/kg cadmium and mercury. For PAHs, cleanup and extraction was according to SOP-ST04 and analysis was by GC/MS according to SOP-8905. For pesticides and PCBs, extraction and cleanup were by SOP-9015 and analysis by SOP-ST04. Target detection limits were 5 ng/g (or 0.005 mg/kg) for individual PAHs, and 2 ng/g (or 0.002 mg/kg) for individual pesticides and PCBs when levels of detection were low; in samples with high concentrations the target detection limits were 60 times those values. Table 3-2 provides a list of detection limits achieved in the analyses.

QA/QC for the chemical analyses was provided by the USFWS in accordance with that agency's existing contract with GERG. Method blanks were run with every 20 samples or with every sample set, whichever was more frequent. Blank levels were acceptable if they were no more than three times the MDL. MS/MSD samples were run at the same frequency as method blanks with the spiking level between 3 and 10 times the MDL. Surrogate materials were added (spiked) to each sample (including QC samples) at levels between three and ten times the MDL. In addition, standard reference materials were analyzed at a frequency of one per sample batch (or 20 samples). Criteria for acceptance of analytical results are discussed in Appendix B of the Final Work Plan (SWDIV 1992).

Microtox® testing. Microtox® bioassays were conducted using the solid phase test protocol (Microbics 1991), which is used to measure the toxicity of materials that are tightly bound to particles in soil, sediment, or sludge. The procedure allows the test organisms to come in direct contact with toxicants in an aqueous suspension of the test sample, detecting both the soluble and insoluble organic and inorganic material.

Least tern eggs. Least tern eggs were analyzed for inorganic and organic contaminants if adequate sample biomass was available. However, the sample biomass for single eggs was not always sufficient for all analyses, therefore, the following analyses were performed: six composites and three single eggs were analyzed for all chemicals; two single eggs were analyzed only for organics. Results for inorganics were expressed on dry-weight basis and organics were reported on wet-weight basis. Although wet-weight chemical concentrations in eggs are typically adjusted to fresh wet-weight concentrations (to account for moisture loss that occurs during incubation), this was not done with samples from the NWR because of the manner in which samples were handled (compositing eggs, etc.).

3.5.3 Statistical Methods

The NWR biological analysis results required log transformation to normalize data distributions before statistical analysis. Log transformation is standard for bioaccumulation data and is used in the National Biocontaminants Program because most biological distributions follow a log normal distribution. This was the case for data collected in the NWR Study.

Means were computed (as geometric means) if detected values exceeded 50 percent of the samples. For cases where chemicals were detected in more than 50 percent, means were computed using one-half of the MDL for the "nondetected" values. This procedure is commonly used when contaminant concentrations in biological samples are not normally distributed and when the chemicals are not measurable in all samples. Means presented in this report have been back-transformed as antilogs from the means of log values to produce the geometric means.

Chemical concentrations in the salvaged samples were compared to the recollected samples of identical species and sample locations for a given analyte using a series of paired t-tests.

Linear regression analysis was used to evaluate relationships between Microtox® toxicity results and sediment chemistry.

4.0 RESULTS

This section summarizes results of data collection and analysis for the evaluation of watershed and land use, physical oceanography processes, and physical (sediment) and biological (invertebrates, fish, and bird eggs) components of the NWR. Additional detail on results may be found in Appendices A, B, C, and D.

4.1 Watershed and Land Use Characterization

Results from the watershed and land use characterization bear on two components of the Seal Beach NWR study by providing:

- o An understanding of the pathways by which surface runoff, carrying chemicals from the surrounding watershed, could enter the NWR
- o Criteria by which the watersheds of potential comparable sites can be evaluated, should comparable site selection be required for a Phase II effort.

4.1.1 Surface Water Runoff

Figure 4-1 shows the watershed boundaries and major drainage pathways for surface water runoff in Anaheim Bay watershed. The watershed is divided into eight subbasins: NWS Seal Beach and seven subbasins surrounding NWS Seal Beach.

Surface runoff in the Anaheim Bay watershed is highly channelized. Pathways for the majority of surface contaminants into the NWR from the surrounding watershed are through Anaheim Bay via discharges into Anaheim Bay, Huntington Harbour, and Bolsa Bay, with Bolsa Bay flowing into Huntington Harbour. Figure 4-2 indicates discharge points for surface runoff from the subbasins in the Anaheim Bay watershed and water quality sample locations for the EPA STORET system database. These data indicate that potential contaminants may enter the NWR as runoff mixed with Anaheim Bay water during tidal exchange (STORET data are presented as Attachment 2 of Appendix A). No STORET data were available for the NWS Subbasin of the watershed.

4.1.2 Comparable Location Criteria and Evaluation

The Final Work Plan for the Wildlife Refuge Study at Seal Beach NWR includes the identification of criteria for potential comparable locations for possible sampling in a Phase II effort, if necessary. The locations considered should be comparable, to the greatest degree possible, to the ecological community in the tidal saltmarsh in the NWR and the Anaheim Bay watershed. Characterization of the Anaheim Bay watershed yielded the following criteria by which to evaluate potential comparable locations with respect to size, topography, land use, soils, hydrology, precipitation, and land use.

Size. The total Anaheim Bay watershed area, including the NWS, includes 48,000 to 50,000 acres. The surface area of the Anaheim Bay system

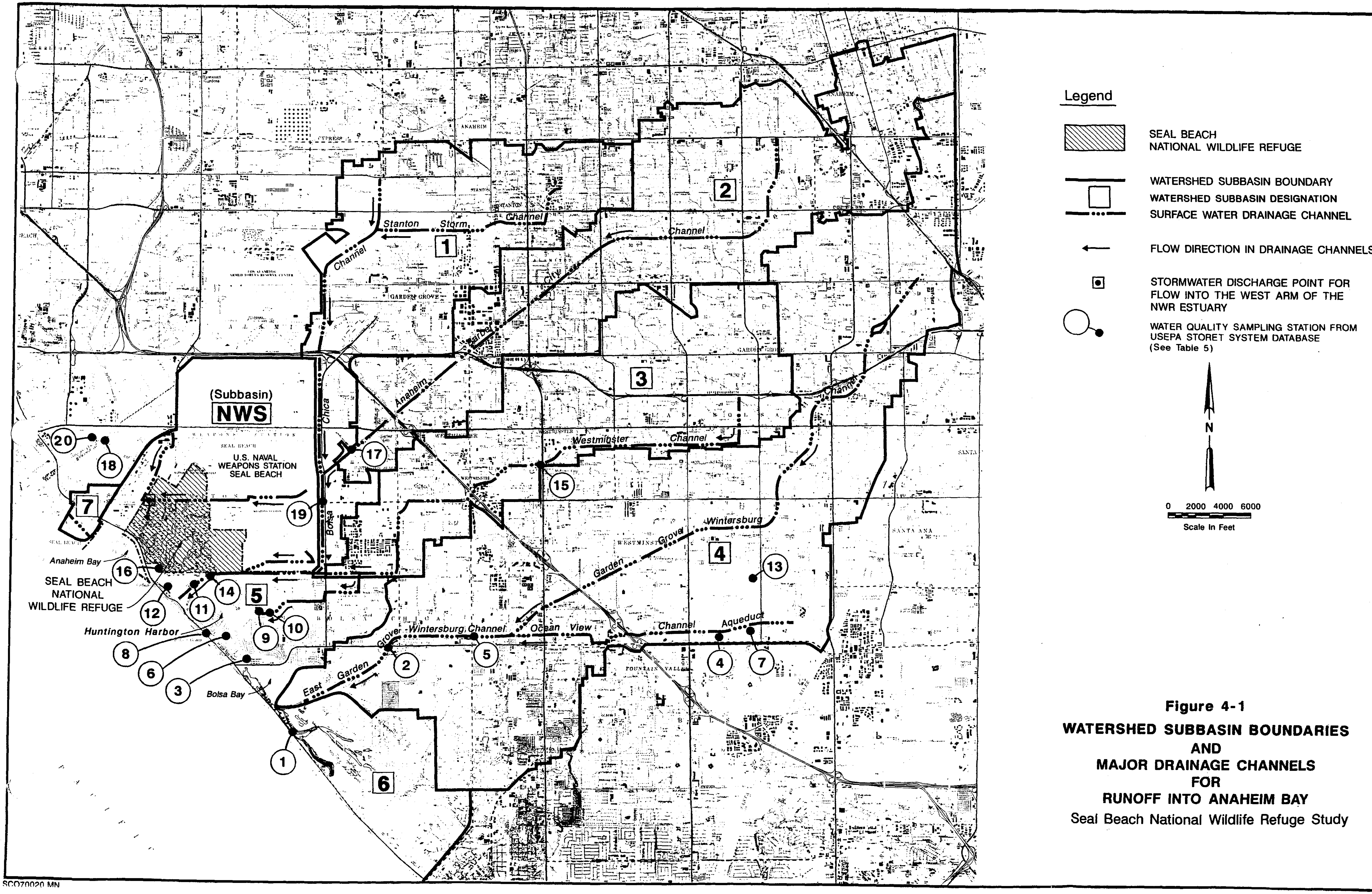
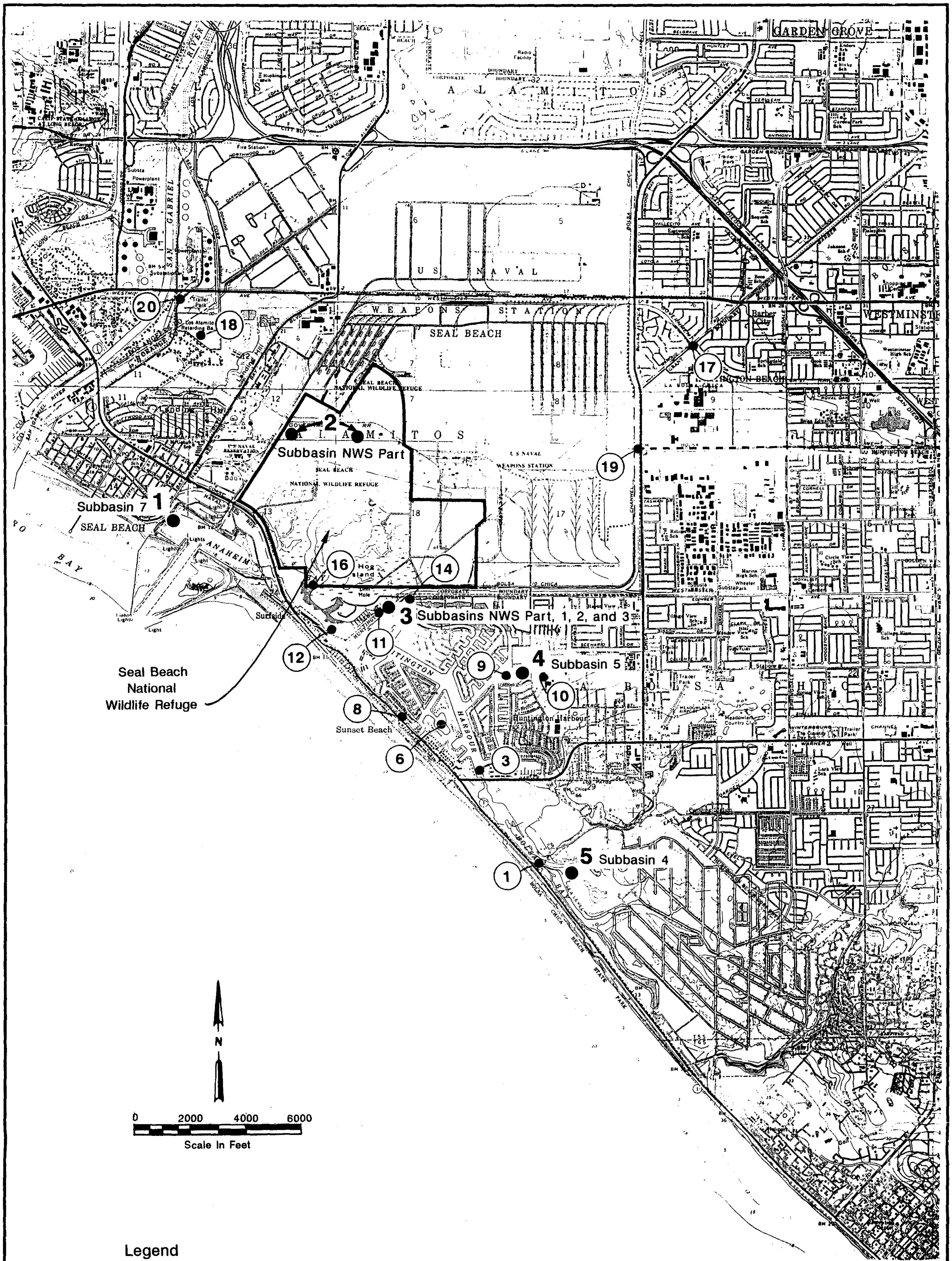


Figure 4-1

WATERSHED SUBBASIN BOUNDARIES
AND
MAJOR DRAINAGE CHANNELS
FOR
RUNOFF INTO ANAHEIM BAY

Seal Beach National Wildlife Refuge Study



Legend

● Discharge Point

○● Water Quality Sampling Station From USEPA Storet System Database (See Appendix A)

Figure 4-2
DISCHARGE POINTS FOR RUNOFF FROM ANAHEIM BAY WATERSHED
Seal Beach National Wildlife Refuge Study

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(including Anaheim Bay, the NWR, Huntington Harbour, and Bolsa Bay) is between 1,400 and 1,900 acres, resulting in a watershed to Bay system ratio ranging from approximately 25:1 to 36:1.

Topography. The Anaheim Bay watershed consists of a flat, coastal plain with average slopes for the Subbasins 1 through 5 and 7 of less than 0.3 percent. The western portion of Subbasin 6 is predominantly marshland at or near sea level, with hills at elevations reaching 125 feet on the eastern end. The average slope from the eastern edge of the watershed to the edge of the tidal saltmarsh is about 2.3 percent.

Land use. The Anaheim Bay watershed is urbanized and largely occupied by residential development with supporting park, school, and commercial developments interspersed throughout. Subbasin NWS (Figure 4-1) supports some seasonal agricultural activity.

Soils. Soil patterns classified as Hueneme-Bolsa associations make up approximately 70 percent of the total watershed area. These soils have moderate to slow rates of water transmission resulting in moderate to high rates of runoff. Pockets of Metz-San Emigdio and Sorrento-Mocho association soils account for 20 to 25 percent on the northeast portion of the watershed. These soils have moderate to high rates of water transmission resulting in relatively low runoff potential. The remaining 5 to 10 percent of the watershed consists of pockets of Myford and Alo-Bosanko association soils along the coastline. These soils have very slow rates of water transmission with high runoff potential. A soils map for the Anaheim Bay watershed is presented as Figure 3 of Appendix A.

Hydrology. Precipitation patterns for the inland portion of the watershed indicate a mean annual precipitation of between 11.8 and 12.4 inches for a record period from 1957 through 1980. Rainfall in this area, however, is highly variable with annual totals ranging from a low of 3.4 inches in 1961 to a high of 26.3 inches in 1978. Mean monthly rainfall values are highest from November through April, with a peak in February of 2.8 inches. Little to no precipitation typically occurs during the remaining months. Most surface runoff into Anaheim Bay from the watershed subbasins is associated with storm events during the winter and early spring corresponding to periods of higher precipitation.

In order to provide a measure of the background chemical levels in the NWR (those that would occur in the absence of NWS Seal Beach), the comparable location can have no military installation within its watershed.

Evaluation of potential comparable locations. Several potential comparable locations, and the physical and ecological attributes of each, were identified by examining maps and aerial photographs of the Southern California coast, through discussions with Jacobs Engineering Group Inc. (Jacobs) ocean technology scientists and marine biologists who have experience in Southern California tidal saltmarsh systems, and USFWS biologists with Southern California experience.

Potential locations included:

- Bolsa Chica Ecological Reserve
- Newport Bay
- Agua Hedionda
- Batiquitos Lagoon
- San Elijos Lagoon
- Tijuana Estuary
- Buena Vista Lagoon
- Los Penasquitos Lagoon
- Kendall Frost Preserve, Mission Bay

Potential comparable locations and their watersheds were then assessed with respect to the criteria listed above and compared to Seal Beach NWR and the surrounding Anaheim Bay watershed to assess their eligibility as a comparable site with the following results:

Bolsa Chica Ecological Reserve is part of the Anaheim Bay watershed, thus, contamination from surface runoff is not independent of that entering the NWR, eliminating it as a possible comparable location.

Batiquitos Lagoon, San Elijos Lagoon, Buena Vista Lagoon, and Los Penasquitos Lagoon are not open to tidal exchange or are open only occasionally, resulting in different hydrodynamics and ecological conditions from those in the NWR. These locations, therefore, could not serve as comparable sites.

Newport Bay, Kendall Frost Preserve in Mission Bay, and Tijuana Estuary each have one or more military installations located in their watersheds, eliminating them as possible comparable locations.

Agua Hedionda is not ecologically comparable to the NWR, lacking the cordgrass habitat that supports the food-chain species that are ingested by the clapper rail.

Initial assessment of potential comparable locations along the California coast yields no single site that is comparable to the tidal saltmarsh in the NWR, with the exception of a military installation. The value of using a component comparable location (as discussed in the Final Work Plan [SWDIV 1992]) to evaluate background chemical concentrations will need to be evaluated based on results and recommendations from sediment and biological contaminant analyses, the sediment transport evaluation and the potential need for a Phase II effort.

4.2 Physical Oceanography Evaluation

This subsection describes results of analyses to evaluate the movement of sediments that can carry contaminants throughout the NWR, as well as an evaluation of hydrogeologic factors potentially influencing the NWR.

4.2.1 Sediment Transport Analysis

The range of grain sizes (silt and sand) identified in the sediment analyses was used to evaluate threshold velocities and erosion and deposition in the NWR tidal saltmarsh. Grain-size analysis indicated that sediments have a greater fraction of sand-sized particles closer to the mouths and in the main channels of the three arms, and a greater fraction of silt-sized particles at the more landward ends and the tributaries of the main channels. This distribution is a result of the current velocities at which particles with different grain sizes are deposited. The velocity at which particles start to deposit as bottom sediments decreases with sediment particle size. The current velocity in the tidal saltmarsh generally decreases from the mouth of the main tidal channels landward up the tidal saltmarsh and into the tributaries of the main channels. Thus, larger particles are expected to be deposited first (i.e., closer to the mouth). Smaller particles are deposited farther into the tidal saltmarsh where current velocities are generally lower.

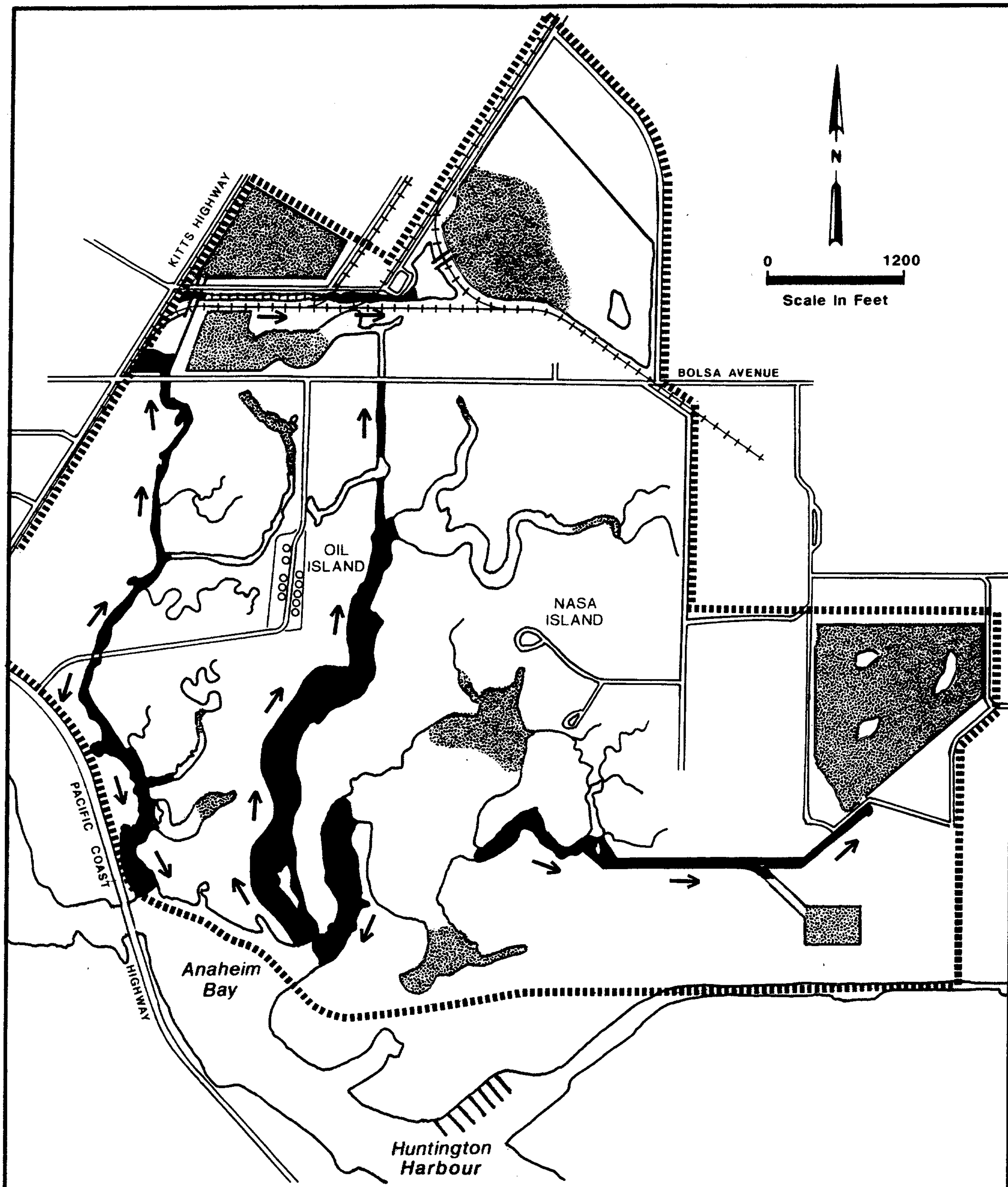
4.2.2 Deposition/Erosion Analysis

Based on the relationship developed by Hjulström (Appendix B, Figure 9), the velocity required to mobilize sediment with median grain sizes in the sand range can vary from about 18 to 40 centimeters per second (cm/sec) (0.6 feet per second [ft/sec]) depending on the value of the median grain size. Current velocities for mobilization of sediment with median sizes in the silt range can range from about 25 to 190 cm/sec (0.8 to 6.2 ft/sec) depending on the value of the median grain size. Similarly, threshold velocities for deposition of suspended sediments range from about 0.38 to 15 cm/sec (1.012 to 0.5 ft/sec) for sand-sized sediments.

Areas that are prone to deposition or erosion can be identified based on the threshold velocities associated with grain size and water depth. In the NWR, the potential for erosion is considered high in areas with average velocities greater than 1.5 ft/sec and moderate in areas with average velocities greater than 0.6 ft/sec corresponding to the approximate threshold velocities required to mobilize silt and fine sand particles, respectively. Areas prone to deposition are considered to be those with maximum velocities less than 0.1 ft/sec corresponding to the velocity at which medium sand will settle out. Figure 4-3 indicates areas in the tidal saltmarsh that are prone to deposition or erosion based on these criteria along with the results of the model runs. Figure 4-3 also illustrates the existing conditions in the tidal saltmarsh, while Figure 4-4 indicates the conditions prior to construction of the POLB ponds.

Under existing conditions, the main channels for all three of the arms of the tidal saltmarsh generate sufficient velocities over most of their lengths to mobilize bottom sediments. Areas that are prone to deposition are at the ends of the smaller tributary channels and in the POLB ponds.

Models of the pre-POLB pond conditions for the west and east arms show much less tendency for erosion than under existing conditions. The west arm model results indicate that sufficient velocities could have been developed over



LEGEND

NWR BOUNDARY

HIGH EROSION POTENTIAL

DEPOSITION-PRONE AREAS

DOMINANT TRANSPORT DIRECTION

FIGURE 4-3
SEDIMENT TRANSPORT POTENTIAL
OF SEAL BEACH NWR

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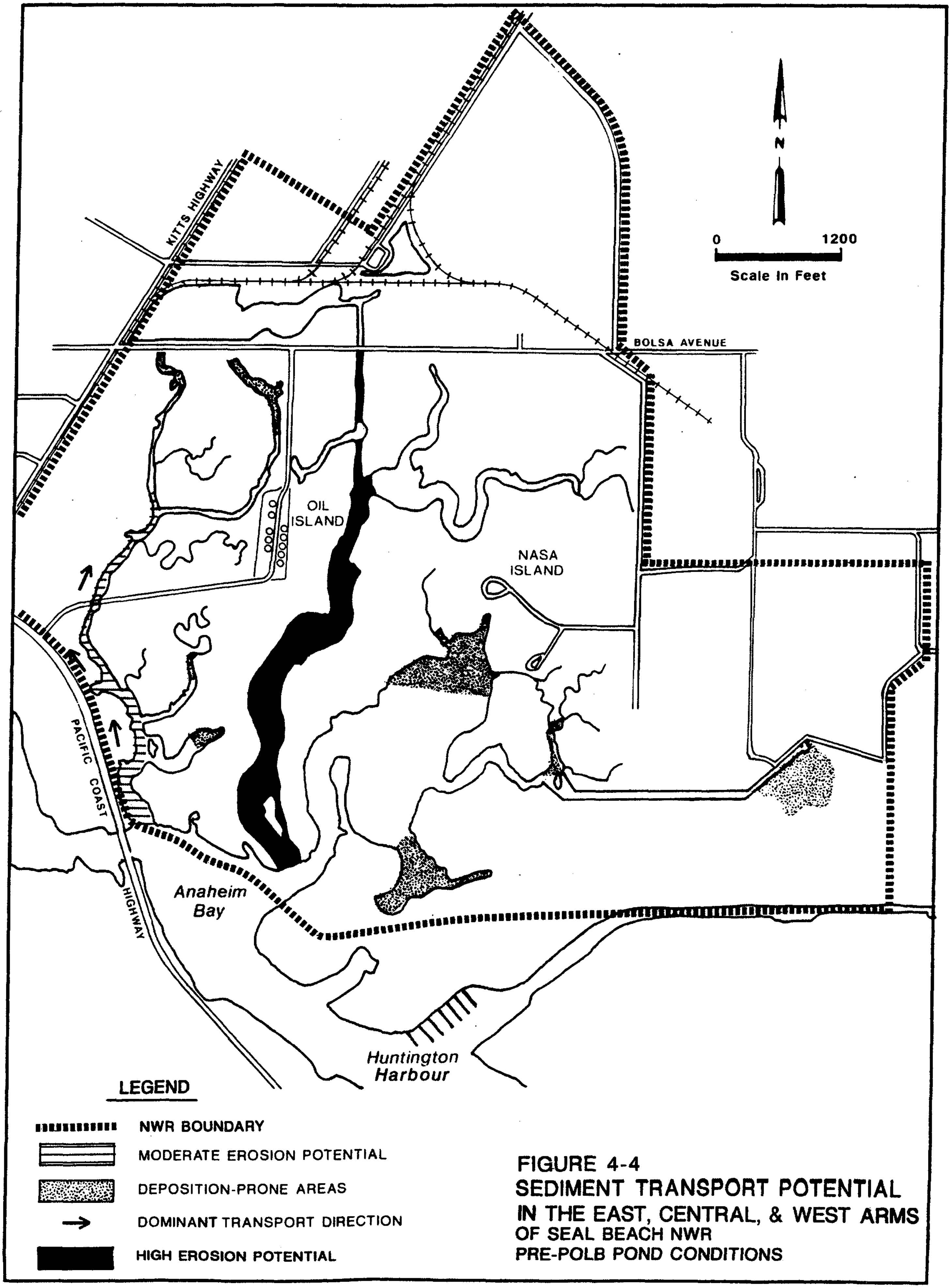

FIGURE 4-4
SEDIMENT TRANSPORT POTENTIAL
IN THE EAST, CENTRAL, & WEST ARMS
OF SEAL BEACH NWR
PRE-POLB POND CONDITIONS

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the lower two-thirds of the arm to mobilize sand-sized particles, with deposition potential at the end of the main channel and ends of the minor branch channels. The east arm results indicate that without the POLB ponds, there was little to no tendency for erosion through the main channel. Again, areas at the ends of the main and branch channels are prone to deposition.

Threshold velocities determined above for sediment mobilization assume that the bottom sediments are exposed directly to the currents. Field observations indicate that eel grass was observed growing in many areas of the tidal saltmarsh. Eel grass has the effect of sheltering the bottom sediments from the currents, reducing the potential for sediment movement in some areas, and increasing the potential for deposition in others.

Although eel grass will reduce the amount of sediment mobilization, patches of exposed sediments appear to be present in most sections of the tidal saltmarsh. As a result, the potential for sediment mobilization remains in most areas, as shown in Figure 4-3.

Eel grass may increase sedimentation in some areas of the NWR, especially in some of the marginally deposition-prone areas in which larger particles first begin to settle out. As such, the areas shown in Figure 4-3 to be deposition-prone may be expanded some due to eel grass near their borders. Eel grass could also hinder movement of larger sized particles in areas that are shown in Figure 4-3 to have moderate to high erosion potentials but would not be expected to have much effect in these areas on smaller silt-sized particles that are more easily carried with the currents. Although eel grass can affect sedimentation and erosion to the extent described above, eel grass in the Seal Beach NWR estuary should not change the general sediment transport characterization shown in Figure 4-3.

4.2.3 Hydrogeologic Analysis

Well data collected during the RI at Site 1, located approximately 600 feet north of POLB Pond 2 (see Figure 1-2), showed that the wells contained water with salinity comparable to that of seawater, indicating a possible hydraulic connection with waters of the NWR (SWDIV 1994a). The data also indicated a groundwater gradient toward the northwest, away from the NWR. If these wells are hydraulically connected with and discharging to the NWR, groundwater contaminants could be discharged to the NWR. Given the shallow groundwater gradient to the northwest, it is unlikely that the water in the wells in being discharged to the NWR. If these wells were discharging to the NWR, the concentrations of potential contaminants would likely be largely reduced at the tidal-water interface. Groundwater, thus, is not expected to be a significant source of contamination to the NWR. Additional information on the status of groundwater contaminants at Installation Restoration Program sites is included in the Draft Final Remedial Investigation Report (SWDIV 1994a).

4.3 Sediment Chemical Evaluation

This subsection includes results from the sediment chemical analyses, which provide information on the status and spatial distribution of sediment contaminants in the NWR. This information is important to assess potential sources of contaminants, understand the potential consequences of sediment transport in the NWR, and evaluate the status of contaminants in the biota in the NWR.

4.3.1 Inorganics

Concentrations of arsenic, chromium, copper, lead, nickel, silver, and zinc (Table 4-1) in some samples exceeded the no-observed effects levels (NOEL), as shown in Table 4-2 (State of California 1993). Silver barely exceeded the NOEL of 0.5 mg/kg in one sample, a field duplicate at sample location E-3. Some concentrations of lead, nickel, and zinc also exceeded the effects range low (ERL) of NOAA (Table 4-2). Exceedances of the ERL were most common for zinc, although the highest concentration of zinc observed (210 mg/kg) was only three times the NOEL and less than two times the ERL. Similarly, the highest concentrations of lead and nickel were about three times the NOEL (Table 4-2).

Concentrations of metals, acid volatile sulfide, and total organic carbon (TOC) observed in sediment from Seal Beach NWR are shown in Table 4-1. Aluminum, iron, and manganese are not contaminants of concern. They are included in Table 4-1 because they are useful for interpreting the data on other metals with regard to whether concentrations observed represent contamination or natural (geologic) background. Background concentrations for metals in the Southern California Bight, obtained or derived from several sources, are shown in Table 4-3. These are reasonable geologic background values.

A possible approach for evaluating whether metals are present as contaminants or as geological constituents of sediments has been proposed for other areas such as Florida (Schropp et al. 1990) and Louisiana (Pardue et al. 1992). Those authors established relationships between concentrations of heavy metals and aluminum, which is an abundant metallic component of most soils, from "clean" areas. In contrast, they found that in samples from areas influenced by human activity, relative amounts of heavy metals to aluminum were higher than those established relationships for "clean" areas. This approach requires a data set from regional clean areas with a range of concentrations of aluminum and other metals that cover one or more orders of magnitude.

The NWR data do not meet that requirement nor is it known for certain which samples might be "clean." However, the ratios of aluminum to other metals are relatively constant among all of the samples from the NWR, as shown in Table 4-4, which suggests the possibility that variations in concentrations of metals may be due to variations in the major mineral constituents of the sediment (mainly calcium and magnesium), rather than to specific sources of metals contamination. One important qualification to that conclusion, as noted

Table 4-1
Concentrations of Metals and Sulfide (mg/kg dry weight) and
Total Organic Carbon (TOC, in percent)
in Sediments from Seal Beach NWR

Station Name	Sample Name	Aluminum	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Nickel	Silver	Zinc	Sulfide	TOC
A1	1SB	29,200	9.50 a	0.200 U	58.0 a	67.1 a	48,600	38.4 b	681	48.9 b	0.350 U	172 b	50.4	2.36
B1	2SB	23,900	11.0 a	0.450	47.7 a	54.2 a	39,600	52.5 b	464	37.4 b	0.350 U	210 b	728	1.87
B2	3SB	8,930	4.50	0.200 U	16.2	17.1	19,200	26.0 a	196	13.2	0.350 U	73.4 a	322	0.710
C1	4SB	11,000	6.30	0.200 U	21.8	19.4	26,500	15.1	328	17.4 a	0.350 U	77.1 a	34.0	0.380
C2	24SB	18,400	11.9 a	0.250	36.3 a	38.8 a	39,000	30.9 a	476	30.4 b	0.350 U	152 b	60.3	1.29
C2	5SB	21,000	11.0 a	0.240	38.8 a	39.8 a	39,700	31.2 a	546	34.5 b	0.350 U	148 b	81.4	0.750
C3	6SB	23,900	7.30	0.200 U	45.3 a	52.4 a	45,700	32.6 a	534	33.0 b	0.350 U	197 b	1,950	1.95
C4	7SB	22,200	8.00	0.210	37.8 a	44.5 a	38,900	31.1 a	543	30.5 b	0.350 U	168 b	1,050	1.14
D1	8SB	15,700	6.70	0.200 U	24.1	26.2	27,200	20.6	365	19.4 a	0.350 U	102 a	78.5	0.590
D2	9SB	24,700	14.4 a	0.200 U	45.6 a	41.1 a	36,100	23.5 a	502	32.1 b	0.350 U	156 b	143	1.37
D3	10SB	16,700	12.5 a	0.200 U	36.2 a	36.7 a	38,700	32.1 a	528	28.3 a	0.350 U	133 b	175	1.55
E1	11SB	11,800	6.05	0.200 U	27.6	30.4 a	26,300	24.6 a	319	20.7 a	0.350 U	112 a	636	0.890
E2	12SB	21,000	11.2 a	0.200 U	40.1 a	33.3 a	33,500	23.6 a	464	28.0 a	0.350 U	130 b	420	0.590
E3	13SB	14,100	7.40	0.200 U	30.7	36.9 a	27,600	28.3 a	368	22.6 a	0.350 U	170 b	275	1.00
E3	29SB	21,300	6.50	0.200 U	30.4	36.8 a	29,500	26.9 a	389	21.5 a	0.740 a	144 b	201	1.17
E4	14SB	18,500	17.5 a	0.200 U	44.8 a	49.6 a	45,500	28.0 a	527	35.7 b	0.350 U	148 b		3.01
E4	26SB	23,600	13.7 a	0.200 U	41.6 a	49.8 a	47,000	25.7 a	496	31.7 b	0.350 U	158 b	77.4	2.41
F1	15SB	9,300	5.20	0.200 U	19.2	18.6	17,800	19.7	235	14.5	0.350 U	72.7 a	188	0.580
F1	25SB	10,700	5.10	0.200 U	17.7	16.9	19,800	17.7	234	12.2	0.350 U	73.1 a	82.6	1.05
F2	16SB	15,000	6.40	0.200 U	32.3	35.1 a	27,300	26.4 a	369	23.4 a	0.350 U	131 b	714	1.05
F2	28SB	17,600	6.00	0.200 U	29.2	33.8 a	29,700	24.9 a	364	20.7 a	0.350 U	140 b		1.02
F3	17SB	10,300	5.50	0.200 U	21.5	19.3	16,700	20.6	240	14.5	0.350 U	73.4 a	399	0.720
F4	18SB	15,700	8.20 a	0.200 U	35.7 a	36.4 a	29,100	26.2 a	382	25.5 a	0.350 U	120 a	456	1.02
F5	19SB	14,400	5.60	0.200 U	28.7	22.3	21,500	19.7	309	18.7 a	0.350 U	80.9 a	197	0.270
F5	27SB	15,400	4.30	0.200 U	23.5	22.7	28,000	20.7	370	16.7 a	0.350 U	99.0 a	204	0.230
G1	20SB	13,800	11.2 a	0.200 U	31.2	28.5 a	29,200	16.3	361	25.0 a	0.350 U	88.3 a	30.1	1.94
G2	21SB	7,360	4.60	0.200 U	16.1	19.7	13,700	19.9	187	12.3	0.350 U	67.3	83.2	0.630
G3	22SB	15,400	5.70	0.200 U	34.0 a	35.3 a	29,600	25.0 a	399	24.9 a	0.350 U	135 b	657	0.660
H1	23SB	6,920	3.00	0.200 U	14.1	11.6	11,300	17.4	168	10.3	0.350 U	48.3	85.9	0.170

a Exceeds the NOEL sediment screening standard
b Exceeds the ERL sediment screening standard
U Undetected. Value equals detection limit.

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Table 4-2
Comparison of Sediment Screening[1] Levels Developed by NOAA (Long and Morgan, 1990) and the State of Florida (1992) (from State of California, 1993)

Substance	NOEL[2]	ERL[3]	PEL[4]	ERM[5]
Organics in ug/kg or ppb				
Total PCBs	25	50	270	380
Acenaphthene	22	150	450	650
Anthracene	85	85	800	960
Fluorene	18	35	460	640
2-methyl naphthalene		65		670
Naphthalene	130	340	1,100	2,100
Phenanthrene	140	225	1,200	1,380
Total low molecular weight-PAHs	250		2,400	
Benz(a)anthracene	160	230	1,300	1,600
Beno(a)pyrene	220	400	1,700	2,500
Chrysene	220	400	1,700	2,800
Dibenzo(a,h)anthracene	31	60	320	260
Fluoranthene	380	600	3,200	3,600
Pyrene	290	350	1,900	2,200
Total high molecular weight-PAHs	875		8,500	
Total PAHs	2,900	4,000	28,000	35,000
4,4-DDE	1.7	2	130	15
Total DDT	4.5	3	270	350
Metals in mg/kg or ppm				
Arsenic	8	33	64	85
Cadmium	1	5	7.5	9
Chromium	33	80	290	145
Copper	28	70	170	390
Lead	21	35	160	110
Mercury	0.15	0.15	1.4	1.3
Nickel	15	30	50	50
Silver	0.5	1	2.5	2.2
Zinc	68	120	300	270

[1] *Values are for bulk sediment chemistry on a dry-weight basis.*
[2] NOEL is defined as the sediment concentration below which adverse effects are not likely to occur. The value is derived by taking the geometric mean of 15th percentile of the effects database and the 50th percentile of the no-effects database and dividing by a safety factor of 2. (State of Florida, 1993)
[3] The ERL is analogous to the NOEL. It is the concentration below which adverse effects are seldom expected. It is developed by taking the 10th percentile of the ranked adverse effects data in the Long and Morgan database. (Long and Morgan, 1990)
[4] PEL is that concentration above which adverse biological effects are likely to occur. It is developed by taking the geometric mean of the 50th percentile value of the effects database and the 85th percentile value of the no-effects database. (State of Florida, 1993)
[5] The ERM is analogous to the PEL. It is that concentration above which adverse effects are likely. It is developed by taking the 50th percentile of the ranked adverse effects data in the Long and Morgan database. (Long and Morgan, 1990)

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Table 4-3
Regional Background Concentrations of Metals in Offshore Sediments

Metal	Background[a,b,c,d] Concentrations (mg/kg dry weight)
Arsenic	10[a]
Barium	490[b]
Beryllium	6[c]
Cadmium	0.55[d] (0.4[a])
Cobalt	8[c]
Chromium	29.7[d,e]
Copper	6.94[d], 10[a]
Iron	19,000 to 30,000[d]
Lead	6.02[d], 10[a]
Mercury	0.05[a]
Nickel	23.2[d]
Selenium	0.2 to 0.3 up to 1.0[a]
Silver	0.51[d], 0.01 to 0.1[a]
Tin	1.18 to 11.06[f]
Vanadium	103[d]
Zinc	44.6[d], 40 to 60[a]

[a]From Mearns et al. (1991).
[b]Calculated from data in Katz and Kaplin (1981).
[c]From Lindsay (1979).
[d]From Katz and Kaplin (1981).
[e]Could be lower in bays and harbors according to Mearns et al. (1991).
[f]From Anderson, Bay, and Thompson (1988); Los Angeles and Long Beach harbors.

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Table 4-4
Ratios of Aluminum Content to Priority Pollutant Metals

Station Name	Sample Name	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
A1	1SB	3,070 a	146,000 U	503 a	435 a	760 b	597 b	169 b
B1	2SB	2,170 a	53,100	501 a	441 a	455 b	639 b	114 b
B2	3SB	1,980	44,600 U	551	522	344 a	676	122 a
C1	4SB	1,750	55,100 U	506	568	730	634 a	143 a
C2	24SB	1,540 a	73,500	506 a	474 a	596 a	605 b	121 b
C2	5SB	1,910 a	87,500	541 a	528 a	674 a	609 b	142 b
C3	6SB	3,280	120,000 U	528 a	457 a	733 a	725 b	121 b
C4	7SB	2,780	106,000	588 a	499 a	714 a	729 b	132 b
D1	8SB	2,350	78,700 U	653	600	762	811 a	154 a
D2	9SB	1,720 a	124,000 U	543 a	602 a	1,055 a	771 b	159 b
D3	10SB	1,330 a	83,300 U	460 a	455 a	520 a	589 a	125 b
E1	11SB	1,950	58,900 U	427	388 a	478 a	570 a	105 a
E2	12SB	1,880 a	105,000 U	524 a	631 a	892 a	750 a	162 b
E3	13SB	1,910	70,500 U	460	382 a	498 a	624 a	83 b
E3	29SB	3,280	107,000 U	702	580 a	793 a	992 a	148 b
E4	14SB	1,060 a	92,700 U	414 a	374 a	663 a	519 b	125 b
E4	26SB	1,720 a	118,000 U	567 a	473 a	916 a	744 b	149 b
F1	15SB	1,790	46,500 U	484	500	471	641	128 a
F1	25SB	2,090	53,300 U	602	630	602	873	146 a
F2	16SB	2,340	74,900 U	464	427 a	567 a	640 a	114 b
F2	28SB	2,930	87,900 U	602	520 a	706 a	850 a	126 b
F3	17SB	1,870	51,300 U	478	532	498	708	140 a
F4	18SB	1,910 a	78,300 U	438 a	430 a	597 a	614 a	131 a
F5	19SB	2,570	72,000 U	502	645	731	770 a	178 a
F5	27SB	3,570	76,800 U	653	677	742	920 a	155 a
G1	20SB	1,230 a	69,100 U	443	485 a	845	552 a	156 a
G2	21SB	1,600	36,800 U	457	374	369	598	109
G3	22SB	2,690	76,800 U	451 a	435 a	615 a	616 a	114 b
H1	23SB	2,310	34,600 U	491	596	397	672	143

a Concentration in Table 4-5 exceeds the NOEL sediment screening standard (Table 4-1)
b Concentration in Table 4-5 exceeds the ERL sediment screening standard (Table 4-1)
U Undetected. Value equals detection limit.

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above, is the consistency with which the highest concentrations of several metals were observed at sample locations A-1, B-1, and C-3.

The highest concentrations of arsenic, chromium, and copper were about twice the NOEL, and in many samples, the concentrations of those metals barely exceeded the NOEL, as indicated by comparing Tables 4-1 and 4-2. A safety factor of two was applied in deriving the NOELs (Table 4-2). Note that for arsenic and nickel, the regional background values (Table 4-3) are higher than the NOELs (Table 4-2) and similar to the concentrations at the NWR (Table 4-1) that exceeded the NOELs (Table 4-2). However, nickel at sample location A-1 was twice the regional background and also exceeded the ERL.

The small range of concentrations of metals detected in sediment samples precludes identification of concentration gradients in the NWR that might help identify potential sources of contamination. Further precluding the detection of gradients is that metal concentrations may be related to sediment grain size and TOC, being lower in sandy sediments (shown by grain size analysis to be more common in the seaward portions of the NWR closest to Anaheim Bay) with low TOC. However, the three highest concentrations of chromium were found at A-1, B-1 and D-2, and the three highest concentrations of copper, lead, and zinc were observed at sample locations A-1, B-1, and C-3. Nickel was highest at sample locations A-1, B-1, and E-4 (Table 4-1). These five sample locations are among the more landward locations sampled at the NWR.

4.3.2 Organics

PAHs were observed at several locations at concentrations near detection limits, as shown on Table 4-5. Highest concentrations of individual compounds and of total PAHs were found at sample locations B-1, D-1, and E-1; all of these sample locations are in the west arm of the NWR tidal saltmarsh. Sample location C-1, between D-1 and E-1, had no detected PAHs. Total PAHs were calculated using 0.5 times the detection limits for nondetected compounds. This was done because the presence of some PAHs indicated that others were probably present at concentrations below the detection limits.

All PAH concentrations in sediments were below the NOELs (Table 4-1) and so are not expected to have adverse biological effects.

Detection limits for pesticides and PCBs were consistently higher than the NOELs and ERLs. Therefore, whenever pesticides or PCBs were detected, their concentrations exceeded both the NOELs and the ERLs (Table 4-5).

Total PCBs were detected only in one of two laboratory duplicate analyses at sample location C-3. Metabolites of DDT (4,4′-DDD and 4,4′-DDE) were detected at several locations with 4,4′-DDE being widespread in the NWR. Total DDT (Table 4-5) was calculated using 0.5 times the detection limit for nondetected compounds. Concentrations of DDT were highest at sample location B-1 where 0.181 mg/kg of 4,4′-DDE were observed and 4,4′-DDD was also detected. Sample locations B-2 and C-2 had the second and third

Table 4-5
Concentrations of Organic Constituents in Sediments from Seal Beach NWR

Station Name	Sample Name	Naphthalene	Acenaphthalene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)-anthracene	Chrysene	Perylene
		POLYCYCLIC AROMATIC HYDROCARBONS (All values have units of ppb (ug/kg) dry weight)										
A1	1SBPP	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U
B1	2SBPP	9.51 U	9.51 U	9.51 U	9.51 U	32.2	9.51 U	54.3	54.3	24.1	44.2	16.1
B2	3SBPP	9.45 U	9.45 U	9.45 U	9.45 U	9.45 U	9.45 U	19.2	22.0	11.0	15.1	20.6
C1	4SBPP	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U
C2	24SBPP	11.6 U	11.6 U	11.6 U	11.6 U	11.6 U	11.6 U	21.2	24.1	12.5	23.1	11.6 U
C2	5SBPP	9.79 U	9.79 U	9.79 U	9.79 U	9.79 U	9.79 U	22.6	26.4	11.3	22.6	9.79 U
C3	6SBPP	9.29 U	9.29 U	9.29 U	9.29 U	9.29 U	9.29 U	24.0	24.0	10.9	24.0	9.29 U
C4	7SBPP	9.53 U	9.53 U	9.53 U	9.53 U	9.53 U	9.53 U	17.8	19.7	9.87	19.7	9.53 U
D1	8SBPP	9.41 U	9.41 U	13.2	9.41 U	72.7	23.1	101	97.4	44.6	54.5	13.2
D2	9SBPP	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	16.7	13.9	9.57 U	11.2	27.9
D3	10SBPP	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	11.0	9.96 U	11.0	9.96 U
E1	11SBPP	9.10 U	9.10 U	9.10 U	9.10 U	12.1	15.6	43.3	52.0	20.8	34.7	13.9
E2	12SBPP	9.77 U	9.77 U	9.77 U	9.77 U	9.77 U	9.77 U	10.2	10.2	9.77 U	9.77 U	9.77 U
E3	13SBPP	9.55 U	9.55 U	9.55 U	9.55 U	9.55 U	9.55 U	12.6	14.4	9.55 U	12.6	9.55 U
E3	29SBPP	9.46 U	9.46 U	9.46 U	9.46 U	9.46 U	9.46 U	15.5	17.3	9.46 U	15.5	9.46 U
E4	14SBPP	9.79 U	9.79 U	9.79 U	9.79 U	9.79 U	9.79 U	12.9	15.4	9.79 U	9.79 U	9.79 U
E4	26SBPP	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U	15.1	15.1	12.5 U	12.5 U	12.5 U
F1	15SBPP	9.91 U	9.91 U	9.91 U	9.91 U	9.91 U	9.91 U	16.3	15.6	9.91 U	12.7	9.91 U
F1	25SBPP	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U	12.8	11.2	9.88 U	9.88 U	9.88 U
F2	16SBPP	9.74 U	9.74 U	9.74 U	9.74 U	9.74 U	9.74 U	17.1	17.1	10.2	11.9	9.74 U
F2	28SBPP	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	19.7	17.9	9.96 U	17.9	9.96 U
F3	17SBPP	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U
F4	18SBPP	9.86 U	9.86 U	9.86 U	9.86 U	9.86 U	9.86 U	12.1	13.9	9.86 U	12.1	9.86 U
F5	19SBPP	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
F5	27SBPP	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U
G1	20SBPP	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U
G2	21SBPP	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	24.1	20.9	11.3	20.9	9.81 U
G3	22SBPP	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	10.3	12.1	9.81 U	10.3	9.81 U
H1	23SBPP	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U

a Exceeds the ERL sediment screening standard
b Exceeds the PEL sediment screening standard
U Undetected. Value equals detection limit.
J Estimated. Below CRDL and above IDL/MDL

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Table 4-5
Concentrations of Organic Constituents in Sediments from Seal Beach NWR

Station Name	Sample Name	Benzo(b)-fluoranthene	Benzo(k)-fluoranthene	Benzo(e)-pyrene	Benzo(a) pyrene	Indeno(1,2,3-cd pyrene	Dibenzo(a,h)-anthracene	Benzo(ghi)-perylene	4,4'-DDD	4,4'-DDE	4,4'-DDT	O,P'-DDT
		POLYCYCLIC AROMATIC HYDROCARBONS (Units are ppb (ug/kg) dry weight)							PESTICIDES			
A1	1SBPP	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	18.3 a	9.63 U	9.63 U
B1	2SBPP	26.1	28.1	30.2	26.1	14.1	9.51 U	16.1	40.2	181 b	9.51 U	9.51 U
B2	3SBPP	11.0	11.0	27.5	12.4	9.45 U	9.45 U	9.45 U	27.5	27.5 a	9.45 U	9.45 U
C1	4SBPP	8.98 U	8.98 U	8.98 U	9.0 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U a	8.98 U	8.98 U
C2	24SBPP	16.4	15.4	15.4	15.4	11.6 U	11.6 U	13.5	11.6 U	19.3 a	11.6 U	11.6 U
C2	5SBPP	15.1	15.1	15.1	13.2	9.79 U	9.79 U	11.3	18.8	37.7 a	9.79 U	9.79 U
C3	6SBPP	17.5	19.7	17.5	19.7	15.3	9.29 U	15.3	11.2 U	21.8 a	11.2 U	11.2 U
C4	7SBPP	15.8	15.8	13.8	17.8	13.8	9.53 U	15.8	9.53 U	19.7 a	9.53 U	9.53 U
D1	8SBPP	29.7	33.0	24.8	41.3	23.1	9.41 U	23.1	9.41 U	16.5 a	9.41 U	9.41 U
D2	9SBPP	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U a	9.57 U	9.57 U
D3	10SBPP	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	18.3 a	9.96 U	9.96 U
E1	11SBPP	20.8	22.5	17.3	20.8	10.4	9.10 U	12.1	9.10 U	17.3 a	9.10 U	9.10 U
E2	12SBPP	9.77 U	9.77 U	9.77 U	9.77 U	9.77 U	9.77 U	9.77 U	9.79 U	9.79 U a	9.79 U	9.79 U
E3	13SBPP	10.8	10.8	9.55 U	10.8	9.55 U	9.55 U	10.8	9.55 U	18.0 a	9.55 U	9.55 U
E3	29SBPP	12.1	13.8	10.4	10.4	9.46 U	9.46 U	10.4	9.46 U	17.3 a	9.46 U	9.46 U
E4	14SBPP	9.79 U	9.79 U	9.79 U	10.3	9.79 U	9.79 U	10.3	9.79 U	9.79 U a	9.79 U	9.79 U
E4	26SBPP	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U a	12.5 U	12.5 U
F1	15SBPP	10.4	11.1	9.91 U	9.91 U	9.91 U	9.91 U	9.91 U	9.91 U	12.7 a	9.91 U	9.91 U
F1	25SBPP	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U a	9.88 U	9.88 U
F2	16SBPP	11.9	11.9	10.2	11.9	9.74 U	9.74 U	10.2	9.74 U	17.1 a	9.74 U	9.74 U
F2	28SBPP	12.5	14.3	10.8	10.8	9.96 U	9.96 U	12.5	9.96 U	17.9 a	9.96 U	9.96 U
F3	17SBPP	9.78 U	14.5	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U a	9.78 U	9.78 U
F4	18SBPP	10.4	12.1	10.4	10.4	9.86 U	9.86 U	9.86 U	9.86 U	17.3 a	9.86 U	9.86 U
F5	19SBPP	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U a	10.0 U	10.0 U
F5	27SBPP	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U a	9.90 U	9.90 U
G1	20SBPP	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U a	9.64 U	9.64 U
G2	21SBPP	16.1	17.7	12.9	14.5	12.9	9.81 U	14.5	9.81 U	16.1 a	9.81 U	9.81 U
G3	22SBPP	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	17.2 a	9.81 U	9.81 U
H1	23SBPP	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	14.4 a	9.57 U	9.57 U

a Exceeds the ERL sediment screening standard
b Exceeds the PEL sediment screening standard
U Undetected. Value equals detection limit.
J Estimated. Bleow CRDL and above IDL/MDL

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Table 4-5
Concentrations of Organic Constituents in Sediments from Seal Beach NWR

Station Name	Sample Name	TOTALIZED VALUES				
		Total PCB	Total LMW PAH	Total HMW PAH	Total PAH	Total DDT
A1	1SBPP	9.63 U	28.9 U	60.0 U	88.9 U	32.7 J a
B1	2SBPP	9.51 U	55.9 J	339 J	395 J	231 J a
B2	3SBPP	9.45 U	28.3 U	165 J	193 J	64.4 J a
C1	4SBPP	8.98 U	26.9 U	60.0 U	86.9 U	18.0 U a
C2	24SBPP	11.6 U	34.7 U	172 J	207 J	36.6 J a
C2	5SBPP	9.79 U	29.4 U	168 J	197 J	66.3 J a
C3	6SBPP	125 2	27.9 U	198 J	226 J	38.7 J a
C4	7SBPP	9.53 U	28.6 U	170 J	198 J	34.0 J a
D1	8SBPP	9.41 U	123 J	490 J	614 J	30.6 J a
D2	9SBPP	9.57 U	28.7 U	110 J	138 J	19.1 U a
D3	10SBPP	9.96 U	29.9 U	71.9 J	102 J	33.2 J a
E1	11SBPP	9.10 U	45.9 J	274 J	319 J	31.0 J a
E2	12SBPP	9.79 U	29.3 U	70.5 J	99.8 J	19.6 U a
E3	13SBPP	9.55 U	28.7 U	108 J	136 J	32.3 J a
E3	29SBPP	9.46 U	28.4 U	125 J	154 J	31.5 J a
E4	14SBPP	9.79 U	29.4 U	88.8 J	118 J	19.6 U a
E4	26SBPP	12.5 U	37.5 U	80.3 J	118 J	25.0 U a
F1	15SBPP	9.91 U	29.7 U	101.1 J	131 J	27.6 J a
F1	25SBPP	9.88 U	29.6 U	73.9 J	104 J	19.8 U a
F2	16SBPP	9.74 U	29.2 U	128 J	157 J	31.7 J a
F2	28SBPP	9.96 U	29.9 U	136 J	166 J	32.9 J a
F3	17SBPP	9.78 U	29.3 U	69.5 J	98.8 J	19.6 U a
F4	18SBPP	9.86 U	29.6 U	106 J	136 J	32.1 J a
F5	19SBPP	10.0 U	30.1 U	60.0 U	90.1 U	20.0 U a
F5	27SBPP	9.90 U	29.7 U	60.0 U	89.7 U	19.8 U a
G1	20SBPP	9.64 U	28.9 U	60.0 U	88.9 U	19.3 U a
G2	21SBPP	9.81 U	29.4 U	176 J	205 J	30.8 J a
G3	22SBPP	9.81 U	29.4 U	77.7 J	107 J	31.9 J a
H1	23SBPP	9.57 U	28.7 U	6.0 U	34.7 U	28.7 J a

a Exceeds the ERL sediment screening standard
b Exceeds the PEL sediment screening standard
U Undetected. Value equals detection limit.
J Estimated. Below CRDL and above IDL/MDL

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highest concentrations of 4,4′-DDE, with 4,4′-DDD detected in one of two duplicate samples from C-2.

The detected concentration of the 4,4′-DDE at sample location B-1 was above the probable effects level (PEL) of 0.130 ppm (Table 4-1). Concentrations at other locations where 4,4-DDE was detected (Table 4-5) were one-fifth to one-sixth of the PEL, but generally over the effects range median (ERM). Since the ERM for 4,4′-DDE is lower than the PEL, it was exceeded in 17 of the 19 samples where 4,4′-DDE was detected.

Pesticide concentrations in sediments in the NWR were found to be comparable to those in Los Angeles Harbor and other Southern California bays and harbors (Mearns et al. 1991). Gradients based on dry-weight concentrations of nonpolar organic compounds can be misleading because those compounds are most likely adsorbed to organic matter in the sediment. Organic contaminant concentrations normalized to 1/kg TOC are shown in Table 4-6. The TOC-normalized concentration of 4,4-DDE at sample location H-1, the outermost sample location, was similar to the TOC normalized concentration at sample location B-1, among the most landward sample locations. By contrast, the gradients indicated for the TOC-normalized PAH were similar to those for the dry weight-normalized PAH, with the highest concentrations of detected compounds occurring at sample locations D-1 and C-1, respectively.

4.4 Biological Chemical Evaluation

4.4.1 Analysis Results

Chemical concentrations in invertebrate and fish tissue were originally reported by the GERG in mg/kg on a dry-weight basis for inorganic analytes and on a wet-weight basis for organic analytes. Results are reported here on those same bases. Some toxicity information is available on a wet-weight basis for inorganics or on a lipid-standardized basis for organic analytes. Using the information on average moisture and lipid content for each species given in Table 4-7, it is possible to convert results between dry-weight, wet-weight, and lipid-weight standardized values to obtain approximate values based on the following formulas:

- o Dry-Weight Concentration, mg/kg = (Wet-Weight Concentration, mg/kg) X 100/(100-Moisture percent)

- o Wet-Weight Concentration, mg/kg = (Dry-Weight Concentration, mg/kg/100) X (100-Moisture percent)

- o Lipid-Weight Concentration, mg/kg = (Wet-Weight Concentration, mg/kg) / (Lipid percent / 100)

Salvaged samples. The 18 invertebrate and fish samples salvaged from the group of thawed samples that had been stored in glass jars for organic

Table 4-6
TOC-Normalized Concentrations of Organic Constituents on Sediment from Seal Beach NWR

Station Name	Sample Name	POLYCYCLIC AROMATIC HYDROCARBONS (All values have units of ug/kg TOC)										
		Naphthalene	Acenaphthalene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)-anthracene	Chrysene	Perylene
A1	1SBPP	408 U	408 U	408 U	408 U	408 U	408 U	408 U	408 U	408 U	408 U	408 U
B1	2SBPP	508 U	508 U	508 U	508 U	1,720	508 U	2,900	2,900	1,290	2,370	860
B2	3SBPP	1,390 U	1,390 U	1,390 U	1,390 U	1,390 U	1,390 U	2,830	3,230	1,620	2,220	3,030
C1	4SBPP	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U
C2	24SBPP	897 U	897 U	897 U	897 U	897 U	897 U	1,640	1,870	971	1,790	897 U
C2	5SBPP	1,310 U	1,310 U	1,310 U	1,310 U	1,310 U	1,310 U	3,010	3,520	1,510	3,010	1,310 U
C3	6SBPP	477 U	477 U	477 U	477 U	477 U	477 U	1,230	1,230	560	1,230	477 U
C4	7SBPP	836 U	836 U	836 U	836 U	836 U	836 U	1,560	1,730	866	1,730	836 U
D1	8SBPP	1,490 U	1,490 U	2,100	1,490 U	11,500	3,670	16,000	15,500	7,080	8,650	2,100
D2	9SBPP	698 U	698 U	698 U	698 U	698 U	698 U	1,220	1,020	698 U	814	2,040
D3	10SBPP	643 U	643 U	643 U	643 U	643 U	643 U	643 U	708	643 U	708	643 U
E1	11SBPP	1,020 U	1,020 U	1,020 U	1,020 U	1,360	1,750	4,870	5,840	2,340	3,890	1,560
E2	12SBPP	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,620	1,620	1,550 U	1,550 U	1,550 U
E3	13SBPP	955 U	955 U	955 U	955 U	955 U	955 U	1,260	1,440	955 U	1,260	955 U
E3	29SBPP	809 U	809 U	809 U	809 U	809 U	809 U	1,330	1,480	809 U	1,330	809 U
E4	14SBPP	325 U	325 U	325 U	325 U	325 U	325 U	427	512	325 U	325 U	325 U
E4	26SBPP	498 U	498 U	498 U	498 U	498 U	498 U	603	603	498 U	498 U	498 U
F1	15SBPP	1,710 U	1,710 U	1,710 U	1,710 U	1,710 U	1,710 U	2,820	2,680	1,710 U	2,190	1,710 U
F1	25SBPP	941 U	941 U	941 U	941 U	941 U	941 U	1,220	1,060	941 U	941 U	941 U
F2	16SBPP	927 U	927 U	927 U	927 U	927 U	927 U	1,630	1,630	975	1,140	927 U
F2	28SBPP	977 U	977 U	977 U	977 U	977 U	977 U	1,930	1,760	977 U	1,760	977 U
F3	17SBPP	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U
F4	18SBPP	967 U	967 U	967 U	967 U	967 U	967 U	1,190	1,360	967 U	1,190	967 U
F5	19SBPP	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U
F5	27SBPP	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U
G1	20SBPP	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U
G2	21SBPP	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	3,660	3,170	1,710	3,170	1,490 U
G3	22SBPP	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	1,570	1,830	1,490 U	1,570	1,490 U
H1	23SBPP	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U

a Exceeds the ERL sediment screening standard
U Undetected. Values are detection limits.
J Estimated. Below CRDL and above IDL/MDL.

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Table 4-6
TOC-Normalized Concentrations of Organic Constituents on Sediment from Seal Beach NWR

		POLYCYCLIC AROMATIC HYDROCARBONS (Units are ug/kg TOC)							PESTICIDES (ug/kg TOC)			
Station Name	Sample Name	Benzo(b)-fluoranthene	Benzo(k)-fluoranthene	Benzo(e)-pyrene	Benzo(a) pyrene	Indeno(1,2,3-cd) pyrene	Dibenzo (a,h)-anthracene	Benzo(ghi)-perylene	4,4'-DDD	4,4'-DDE	4,4'-DDT	O,P'-DDT
A1	1SBPP	408 U	408 U	408 U	408 U	408 U	408 U	408 U	408 U	774	408 U	408 U
B1	2SBPP	1,400	1,510	1,610	1,400	753	508 U	860	2,150	9,680	508 U	508 U
B2	3SBPP	1,620	1,620	4,040	1,820	1,390 U	1,390 U	1,390 U	4,040	4,040	1,390 U	1,390 U
C1	4SBPP	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U
C2	24SBPP	1,270	1,190	1,190	1,190	897 U	897 U	1,050	897 U	1,490 a	897 U a	897 U
C2	5SBPP	2,010	2,010	2,010	1,760	1,310 U	1,310 U	1,510	2,510	5,020	1,310 U	1,310 U
C3	6SBPP	896	1,010	896	1,010	784	477 U	784	576 U	1,120 a	576 U a	576 U
C4	7SBPP	1,380	1,380	1,210	1,560	1,210	836 U	1,380	836 U	1,730	836 U	836 U
D1	8SBPP	4,720	5,240	3,930	6,550	3,670	1,490 U	3,670	1,490 U	2,620	1,490 U	1,490 U
D2	9SBPP	698 U	698 U	698 U	698 U	698 U	698 U	698 U	698 U	698 U	698 U	698 U
D3	10SBPP	643 U	643 U	643 U	643 U	643 U	643 U	643 U	643 U	1,180	648 U	643 U
E1	11SBPP	2,340	2,530	1,950	2,340	1,170	1,020 U	1,360	1,020 U	1,950	1,020 U	1,020 U
E2	12SBPP	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U
E3	13SBPP	1,080	1,080	955 U	1,080	955 U	955 U	1,080	955 U	1,800	955 U	955 U
E3	29SBPP	1,030	1,180	885	885	809 U	809 U	885	809 U	1,480	809 U	809 U
E4	14SBPP	325 U	325 U	325 U	342	325 U	325 U	342	325 U	325 U	325 U	325 U
E4	26SBPP	498 U	498 U	498 U	498 U	498 U	498 U	498 U	498 U	498 U	498 U	498 U
F1	15SBPP	1,790	1,920	1,710 U	1,710 U	1,710 U	1,710 U	1,710 U	1,710 U	2,190 a	1,710 U a	1,710 U
F1	25SBPP	941 U	941 U	941 U	941 U	941 U	941 U	941 U	941 U	941 U	941 U	941 U
F2	16SBPP	1,140	1,140	975	1,140	927 U	927 U	975	927 U	1,630	927 U	927 U
F2	28SBPP	1,230	1,410	1,050	1,050	977 U	977 U	1,230	977 U	1,760	977 U	977 U
F3	17SBPP	1,320 U	1,960	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U
F4	18SBPP	1,020	1,190	1,020	1,020	967 U	967 U	967 U	967 U	1,700	967 U	967 U
F5	19SBPP	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U
F5	27SBPP	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U
G1	20SBPP	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U
G2	21SBPP	2,440	2,680	1,950	2,190	1,950	1,490 U	2,190	1,490 U	2,440	1,490 U	1,490 U
G3	22SBPP	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	2,610	1,490 U	1,490 U
H1	23SBPP	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	8,460	5,630 U	5,630 U

a Exceeds the ERL sediment screening standard
U Undetected. Values are detection limits.
J Estimated. Below CRDL and above IDL/MDL.

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Table 4-6
TOC-Normalized Concentrations of Organic Constituents on Sediment from Seal Beach NWR

Station Name	Sample Name	TOTALIZED VALUES (ug/kg TOC) Total PCB	Total LMW PAH	Total HMW PAH	Total PAH	Total DDT
A1	1SBPP	408 U	1,220 U	2,450 U	3,670 U	1,390 J a
B1	2SBPP	508 U	2,990 J	18,100 J	21,100 J	12,300 J a
B2	3SBPP	1,390 U	4,170 U	24,100 J	28,300 J	9,470 J a
C1	4SBPP	2,360 U	7,090 U	14,200 U	21,300 U	4,730 U a
C2	24SBPP	900 U	2,690 U	13,500 J	16,200 J	2,840 J a
C2	5SBPP	1,310 U	3,920 U	22,300 J	26,200 J	8,840 J a
C3	6SBPP	6,400 a	1,430 U	10,100 J	11,500 J	1,980 J a
C4	7SBPP	836 U	2,510 U	14,900 J	17,400 J	2,990 J a
D1	8SBPP	1,490 U	19,500 J	77,800 J	97,300 J	4,860 J a
D2	9SBPP	698 U	2,100 U	7,880 J	9,980 J	1,400 U a
D3	10SBPP	643 U	1,930 U	4,630 J	6,560 J	2,150 J a
E1	11SBPP	1,020 U	5,160 J	30,700 J	35,800 J	3,480 J a
E2	12SBPP	1,550 U	4,650 U	4,020 J	8,670 J	3,110 U a
E3	13SBPP	955 U	2,870 U	10,700 J	13,500 J	3,230 J a
E3	29SBPP	809 U	2,430 U	10,600 J	13,000 J	2,690 J a
E4	14SBPP	325 U	976 U	2,920 J	3,900 J	651 U a
E4	26SBPP	498 U	1,490 U	3,700 J	5,190 J	996 U a
F1	15SBPP	1,710 U	5,120 U	17,400 J	22,500 J	4,750 J a
F1	25SBPP	941 U	2,820 U	6,980 J	9,810 J	1,880 U a
F2	16SBPP	927 U	2,780 U	12,100 J	14,900 J	3,020 J a
F2	28SBPP	977 U	2,930 U	13,400 J	16,300 J	3,220 J a
F3	17SBPP	1,320 U	3,960 U	9,220 J	13,200 J	2,640 U a
F4	18SBPP	967 U	2,900 U	10,400 J	13,300 J	3,150 J a
F5	19SBPP	3,710 U	11,100 U	2,230 U	13,400 U	7,420 U a
F5	27SBPP	4,310 U	12,900 U	25,800 U	38,800 U	8,610 U a
G1	20SBPP	497 U	1,490 U	2,980 U	4,470 U	993 U a
G2	21SBPP	1,490 U	4,460 U	26,600 J	31,100 J	4,670 J a
G3	22SBPP	1,490 U	4,460 U	11,600 J	16,100 J	4,840 J a
H1	23SBPP	5,630 U	16,900 U	33,800 U	50,700 U	16,900 J a

a Exceeds the ERL sediment screening standard
U Undetected. Values are detection limits.
J Estimated. Below CRDL and above IDL/MDL.

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**Table 4-7
Average Moisture and Lipid Content
of Seal Beach NWR Invertebrates
and Fish Sampled for Analysis**

Species	Average Lipid (%)	Average Moisture (%)
Invertebrates		
Horned Snail	0.15	36
Saltmarsh Snail	0.51	39
Striped Shore Crab	0.66	66
Clam	0.16	61
Invertebrate Average	0.46	47
Fish		
Topsmelt	1.04	78
Deepbody Anchovy	2.74	77
Northern Anchovy	1.35	81
Goby	1.28	80
Bay Goby	1.59	79
Killifish	1.16	78
Diamond Turbot	0.73	80
Queenfish	0.63	82
Fish Average	1.61	78

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chemical analyses were analyzed for metals and organic compounds following thawing and refreezing. The results from these salvaged samples were compared with results from recollected samples of the same species from the same location (but different sampling dates). The results were compared statistically using paired t-tests for the most commonly detected metals and organic compounds, which included chromium, copper, lead, zinc, and DDE for all species tested. All t-tests showed no significant differences between group means, indicating that the thawed sample results could be used in combination with the other NWR study data. The data from the salvaged samples, combined with the other NWR study data, yielded the results discussed in this section.

Invertebrate samples. At least six species of invertebrates were collected at the NWR sample locations over the course of the study. The frequency of detection and maximum concentration for each chemical across invertebrate species (and one sample of algae) are shown in Table 4-8. Analytical values above MDLs varied greatly with analyte. A high frequency of metals was detected, while organic contaminants were usually not detected. Table 4-9 shows the geometric mean contaminant concentrations for the NWR invertebrate samples across sites. Only detected chemicals are shown.

Inorganics

The inorganics detected in fewer than half of the total analyses were cadmium, mercury, molybdenum, nickel, selenium, and silver (Table 4-8). The highest concentrations of inorganic chemicals were often found in the least frequently collected species (Table 4-8). The most common, widely distributed food-chain species, the horned snails, usually were less contaminated than other species. The highest concentrations of cadmium, chromium, copper, lead, and nickel were found in filamentous algae, ghost shrimp, and polychaete worms. The maximum mercury value was found in a horned snail sample and the highest zinc concentration was found in saltmarsh snails. In general, these patterns were repeated in the geometric means, although many inorganic chemicals were not detected in frequencies high enough for an accurate computation of means, as shown in Table 4-9.

Organics

DDE in saltmarsh snails was the only organic chemical detected in more than half of the samples. Only 10 of 70 organic analytes showed any detected values in the NWR invertebrate tissue samples. Maximum values of individual organic chemicals were spread among horned snails, saltmarsh snails, and shore crabs (Table 4-8). DDD and PCBs were highest in the shore crab, while the maximum DDE concentration was found in a horned snail sample. Naphthalene, fluoranthenes, pyrenes, and 1,1-biphenyl concentrations were highest in saltmarsh snail samples.

Table 4-8
Frequency of Detection and Maximum Concentration of Chemicals in Seal Beach NWR Invertebrates and Algae

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Chemical[a]	Horned Snail		Saltmarsh Snail		Striped Shore Crab		Ghost Shrimp		Clam		Polychaete Worm		Filamentous Algae	
	N[b]	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.
INORGANICS (mg/kg, dry weight)														
Aluminum	27/27	963	27/27	2,610	26/26	1,850	2/2	2,400	2/2	1,900	3/3	9,200	1/1	7,020
Arsenic	25/27	1.98	26/27	2.92	25/26	7.58	2/2	13.0	2/2	5.91	3/3	29.5	1/1	3.00
Barium	27/27	4.70	22/22	13.4	18/18	12.5	1/1	5.59	--	--	--	--	1/1	24.2
Boron	27/27	13.0	22/22	10.3	18/18	15.3	1/1	18.7	--	--	--	--	1/1	67.5
Cadmium	8/27	0.15	23/27	0.76	8/26	0.23	2/2	0.66	0/2	--	3/3	0.89	0/1	--
Chromium	27/27	12.7	27/27	13.3	26/26	8.89	2/2	10.9	2/2	10.2	3/3	9.62	1/1	92.7
Copper	27/27	33.7	26/26	18.2	26/26	105	2/2	363	2/2	5.36	3/3	86.5	1/1	10.8
Iron	27/27	945	27/27	2,620	26/26	1,800	2/2	2,480	2/2	2,260	3/3	10,200	1/1	7,840
Lead	27/27	2.50	27/27	7.32	25/26	3.09	2/2	8.18	2/2	2.33	3/3	148	1/1	5.00
Magnesium	27/27	4,100	22/22	4,020	18/18	12,100	1/1	8,700	--	--	--	--	1/1	15,600
Manganese	27/27	181	27/27	155	26/26	85.8	2/2	103	2/2	144	3/3	214	1/1	147
Mercury	2/27	0.56	0/27	--	4/26	0.16	0/2	--	0/2	--	1/3	0.11	0/1	--
Molybdenum	0/27	--	0/22	--	0/18	--	0/1	--	--	--	--	--	1/1	11.5
Nickel	0/27	--	2/27	3.20	0/26	--	2/2	5.74	0/2	--	3/3	9.35	1/1	78.9
Selenium	6/27	1.07	8/27	1.14	15/26	1.30	2/2	2.53	1/2	0.88	3/3	2.97	1/1	0.50
Silver	0/27	--	20/22	0.34	9/18	0.73	--	--	--	--	--	--	0/1	--
Strontium	27/27	1,050	22/22	1,330	18/18	2,130	1/1	592	--	--	--	--	1/1	79.3
Vanadium	26/27	6.52	19/22	9.42	12/18	5.34	0/1	--	--	--	--	--	1/1	18.6
Zinc	27/27	61.6	27/27	542	26/26	62.8	2/2	87.3	2/2	106	3/3	113	1/1	38.8

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Table 4-8
Frequency of Detection and Maximum Concentration of Chemicals in Seal Beach NWR Invertebrates and Algae

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	Horned Snail		Saltmarsh Snail		Striped Shore Crab		Ghost Shrimp		Clam		Polychaete Worm		Filamentous Algae	
Chemical[a]	N[b]	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.
ORGANICS (mg/kg, wet weight)														
1,1-Biphenyl	2/27	0.03	3/23	0.03	--	--	--	--	--	--	--	--	--	--
4,4'-DDD	--	--	--	--	1/26	0.02	--	--	--	--	--	--	--	--
4,4'-DDE	4/30	0.05	18/27	0.03	9/26	0.04	--	--	1/3	0.02	--	--	--	--
C1-Pyrenes and Fluoranthenes	--	--	1/27	0.01	--	--	--	--	--	--	--	--	--	--
C1-Naphthalenes	1/27	0.02	--	--	--	--	--	--	--	--	--	--	--	--
C4-Naphthalenes	--	--	1/27	0.01	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	2/30	0.01	--	--	--	--	--	--	--	--	--	--	--	--
PCB-1254	3/28	0.02	5/27	0.27	4/26	0.58	--	--	1/3	0.07	--	--	--	--
PCB-1260	--	--	--	--	2/26	0.02	--	--	--	--	--	--	--	--
PCB-TOTAL	3/30	0.02	5/27	0.28	4/26	0.61	--	--	1/3	0.07	--	--	--	--

[a]Only those chemicals detected in these samples are listed.
[b]N = Number with detectable concentration/number of samples analyzed.

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Table 4-9
Geometric Mean Concentrations of Contaminants in Seal Beach NWR Invertebrates

Sheet 1 of 1

Chemical	Species						All Species
	Horned Snail	Saltmarsh Snail	Striped Shore Crab	Ghost Shrimp	Clam	Polychaete Worms	
INORGANICS (mg/kg, dry weight)							
Aluminum	305.4	689.9	531.7	919.3	1,013	8,842	542.4
Arsenic	1.207	1.442	4.316	8.767	5.047	20.72	2.218
Barium	2.954	5.950	8.851	5.590	NC	NC	4.926
Boron	7.720	6.807	10.71	18.68	NC	NC	8.175
Cadmium	NC	0.203	NC	0.335	NC	0.584	NC
Chromium	11.65	11.41	7.000	8.288	9.767	7.874	9.732
Copper	14.81	11.46	64.71	254.6	4.867	55.24	22.91
Lead	0.979	1.930	1.171	2.477	2.169	25.51	1.466
Magnesium	1,962	2,281	10,310	8,698	NC	NC	3,219
Manganese	65.49	62.15	32.28	65.44	74.663	163.9	54.23
Mercury	NC	NC	NC	NC	NC	NC	NC
Nickel	NC	NC	NC	3.987	NC	8.726	NC
Selenium	NC	NC	0.592	2.459	NC	2.068	NC
Silver	NC	NC	NC	NC	NC	NC	NC
Strontium	946.0	1,151	1,733	591.8	NC	NC	1168
Vanadium	4.764	5.065	3.767	NC	NC	NC	4.553
Zinc	27.75	248.1	49.83	85.34	71.16	102.5	70.05
ORGANICS (mg/kg, wet weight)							
1,1 Biphenyl	NC	NC	NC	NC	NC	NC	NC
4,4'-DDD	NC	NC	NC	NC	NC	NC	NC
4,4'-DDE	NC	0.010	NC	NC	NC	NC	NC
C1-Fluoranthenes & Pyrenes	NC	NC	NC	NC	NC	NC	NC
C1-Naphthalenes	NC	NC	NC	NC	NC	NC	NC
C4-Naphthalenes	NC	NC	NC	NC	NC	NC	NC
Hexachlorobenzene	NC	NC	NC	NC	NC	NC	NC
PCB-1254	NC	NC	NC	NC	NC	NC	NC
PCB-1260	NC	NC	NC	NC	NC	NC	NC
PCB-TOTAL	NC	NC	NC	NC	NC	NC	NC

NC = Geometric Mean not computed because detected concentration occurred in less than half the samples.

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Spatial Patterns

Those species collected at all sample locations (horned snails, saltmarsh snails, shore crabs) allowed a characterization of contaminant spatial heterogeneity, although metals and organic maxima did not follow the same general patterns in distribution. Table 4-10 lists the sample locations for each of those species where the highest concentrations of eight potentially significant chemicals were found. Up to three sample locations with the highest contaminant concentrations are listed by analyte and species, and several sample locations are consistently associated with elevated heavy metal concentrations in invertebrate tissue. Sample locations with the highest values (among the top three for at least two invertebrate species) include B-1, C-1, and F-5 for cadmium, G-3 for copper, G-2 and E-4 for lead, and F-5 for zinc. In contrast, the highest invertebrate concentrations of DDE were found in more than one species at sample locations A-1 and B-1 and of PCBs at E-3, as shown in Table 4-10. (See later discussion comparing observed concentrations to assessment levels.)

Fish samples. Overall frequency of detection and maximum concentrations for chemicals in fish are given in Table 4-11. Fish samples yielded detectable values and calculatable geometric means with a greater frequency than did the invertebrate samples. Geometric mean values for metals and organic contaminants detected in NWR fish are shown in Table 4-12.

The detection frequency for analytes in fish was slightly different than for invertebrate species. Inorganics detected in fewer than half of the total samples were beryllium, cadmium, mercury, molybdenum, nickel, and silver (Table 4-11). In contrast, the only organic analytes detected in more than half of the samples were the DDT derivatives, PCBs, phenanthrenes, and anthracenes (Tables 4-11 and 4-12). Only 19 of 70 organic analytes showed values above detection limits in the NWR fish tissue samples.

Inorganics

Metals of most interest for bioaccumulation and potential toxicity in fish tissue include cadmium, chromium, copper, lead, mercury, nickel, and zinc. With the exception of copper in killifish and mercury in deepbody anchovy, heavy metals were found in highest concentrations in topsmelt samples (Table 4-11). The same general pattern is shown by the geometric means (Table 4-12). As an exception, the high mean concentrations of chromium and mercury in diamond turbot were probably influenced by the small number of diamond turbot samples.

Organics

The inorganic chemical pattern does not hold true for organic contaminants, where high concentrations were more evenly divided between topsmelt and deepbody anchovy. In general, the highest concentrations of biphenyls, DDD, BHC, naphthalenes, and fluorenes were found in topsmelt (Table 4-11).

Table 4-10
Biota Sampling Locations Where Highest Concentrations of Contaminants of Concern Were Found in Commonly Collected Species

Chemical[a]	Invertebrates			Fish
	Horned Snail	Saltmarsh Snail	Striped Shore Crab	Topsmelt
Cadmium	D-2	F-5	F-5	Pond 2
	G-1	A-1	B-1	F-2
	B-1	C-1	C-1	Pond 3
Chromium	D-2	G-3	D-3	Pond 3
	B-1	E-1	E-2	E-1
	F-2	A-1	E-4	B-1
Copper	C-1	F-1	H-1	Pond 3
	E-2	G-3	F-5	E-4
	D-2	E-4	G-3	B-1
Lead	G-2	G-2	E-4	Pond 3
	H-1	C-1	G-1	F-1
	B-1	E-4	F-1	Pond 4
Nickel		G-3		Pond 3
		E-4		E-1
				B-1
Zinc	D-3	F-5	C-2	F-2
	D-2	G-3	B-1	Pond 3
	E-2	B-2	F-5	E-3
DDE	B-1	A-1	B-1	Pond 1
	C-2	B-1	H-1	Pond 2
	A-1	B-2	G-2	C-4
PCBs	E-3	E-3	D-1	Pond 4
	F-1	B-2	H-1	C-4
	E-1	C-1	F-4	Pond 1

[a]For each chemical, and within each species, the locations are listed at which highest concentrations were found. Blank spaces indicate that the chemical was found at less than five locations. Within each species, a particular location is listed only once, even if two samples of that species from that location had among the five highest concentrations (which sometimes occurred).

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Table 4-11
Frequency of Detection and Maximum Concentration of Contaminants in Seal Beach NWR Fish

Chemical[a]	Topsmelt		Deepbody Anchovy		Northern Anchovy		Goby		Killifish		Diamond Turbot		Queenfish	
	N[b]	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.
INORGANICS (mg/kg, dry weight)														
Aluminum	33/33	3,860	9/9	1,140	6/6	800	6/6	565	5/5	1,300	2/2	439	1/1	160
Arsenic	33/33	3.52	9/9	3.67	6/6	4.43	6/6	4.68	5/5	4.14	2/2	3.05	1/1	2.50
Barium	25/25	20.1	8/8	5.69	6/6	4.61	5/5	4.97	4/4	8.81	2/2	3.19	1/1	1.82
Boron	24/24	107	7/7	100	6/6	29.4	4/4	49.1	4/4	18.4	1/2	9.13	1/1	24.3
Cadmium	3/33	0.25	2/9	0.15	0/6	--	1/6	0.16	1/5	0.12	0/2	--	0/1	--
Chromium	33/33	71.2	4/9	18.0	4/6	6.64	5/6	15.3	5/5	18.4	2/2	43.9	1/1	5.61
Copper	33/33	16.2	9/9	3.56	6/6	4.91	6/6	8.56	5/5	21.1	2/2	5.56	1/1	3.66
Iron	32/33	4,220	9/9	1,140	6/6	842	6/6	659	5/5	1,540	2/2	624	1/1	177
Lead	27/33	7.78	2/9	0.64	3/6	0.87	3/6	2.81	2/5	1.31	0/2	--	0/1	--
Magnesium	25/25	4,020	8/8	3,560	6/6	3,690	5/5	2,500	4/4	3,060	2/2	2,570	1/1	2,700
Manganese	33/33	113	9/9	29.0	6/6	26.4	6/6	55.8	5/5	73.5	2/2	59.4	1/1	22.8
Mercury	2/33	0.11	8/9	0.26	0/6	--	1/6	0.11	1/5	0.11	0/2	--	0/1	--
Molybdenum	8/24	110	3/7	100	1/6	4.80	1/4	49.1	1/4	2.60	1/1	4.80	0/1	--
Nickel	26/33	44.5	1/9	11.0	2/6	3.79	4/6	8.29	3/5	9.61	2/2	25.5	1/1	2.84
Selenium	32/33	2.44	9/9	2.40	6/6	1.40	6/6	2.71	5/5	1.49	2/2	1.88	1/1	1.04
Strontium	23/24	206	6/7	181	6/6	158	4/4	174	4/4	349	1/1	137	1/1	158
Vanadium	16/25	10.4	0/8	--	0/6	--	1/5	3.68	1/4	6.26	2/2	4.70	0/1	--
Zinc	33/33	147	9/9	117	6/6	84.0	6/6	99.0	5/5	116	2/2	97.4	1/1	75.3

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Table 4-11
Frequency of Detection and Maximum Concentration of Contaminants in Seal Beach NWR Fish

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Chemical[a]	Topsmelt		Deepbody Anchovy		Northern Anchovy		Goby		Killifish		Diamond Turbot		Queenfish	
	N[b]	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.
ORGANICS (mg/kg, wet weight)														
1,1-Biphenyl	1/10	0.02	--	--	--	--	--	--	--	--	--	--	--	--
4,4'-DDD	6/35	0.08	11/11	0.08	3/5	0.03	2/4	0.02	1/4	0.02	--	--	1/1	0.03
4,4'-DDE	35/35	0.53	11/11	1.58	5/5	0.58	4/4	0.31	4/4	0.14	1/1	0.04	1/1	0.21
o,p'-DDE	--	--	1/11	0.02	--	--	--	--	--	--	--	--	--	--
4,4'-DDT	1/35	0.02	9/11	0.04	--	--	--	--	--	--	--	--	--	--
delta-BHC	1/35	0.01	--	--	--	--	--	--	--	--	--	--	--	--
C1-Naphthalenes	2/37	0.01	--	--	--	--	--	--	--	--	--	--	--	--
C2-Naphthalenes	1/37	0.01	--	--	--	--	--	--	--	--	--	--	--	--
C3-Fluorenes	2/37	0.04	--	--	1/5	0.02	--	--	--	--	--	--	--	--
C3-Naphthalenes	1/37	0.01	1/11	0.03	--	--	--	--	--	--	--	--	--	--
C3-Phenanthrenes and Anthracenes	--	--	--	--	1/5	0.02	--	--	--	--	--	--	--	--
C4-Naphthalenes	--	--	1/11	0.03	--	--	--	--	--	--	--	--	--	--
cis-Nonachlor	1/35	0.02	3/11	0.03	--	--	--	--	--	--	--	--	--	--
trans-Nonachlor	1/35	0.02	10/11	0.04	1/5	0.01	1/4	0.02	--	--	--	--	--	--
Naphthalene	1/37	0.01	--	--	--	--	--	--	--	--	--	--	--	--
PCB-1254	19/35	0.44	10/11	0.73	4/5	0.06	3/4	0.15	3/4	0.10	1/1	0.02	1/1	0.05
PCB-1260	1/35	0.02	--	0.02	1/5	0.02	--	--	--	--	--	--	--	--
PCB-TOTAL	11/35	0.46	10/11	0.74	4/5	0.08	3/4	0.15	3/4	0.10	1/1	0.02	1/1	0.05

[a]Only those chemicals detected in these samples are listed.
[b]N = Number with detectable concentration/number of samples analyzed.

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Table 4-12
Geometric Mean Concentrations of Contaminants in Seal Beach NWR Fish

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Chemical[a]	Topsmelt	Deepbody Anchovy	Northern Anchovy	Goby	Killifish	Diamond Turbot	Queenfish	All Species
INORGANICS (mg/kg, dry weight)								
Aluminum	929.5	171.6	433.8	360.9	254.2	387.1	159.5	534.3
Arsenic	2.09	2.28	3.35	2.53	2.00	1.83	2.50	2.22
Barium	5.97	1.19	2.30	2.60	3.68	3.17	1.82	3.54
Boron	15.71	16.63	11.76	13.25	12.95	9.13	24.28	14.61
Cadmium	NC	NC	NC	NC	NC	NC	NC	NC
Chromium	14.01	4.10	4.45	6.75	7.87	27.55	5.61	10.10
Copper	7.64	2.71	4.56	4.35	10.34	4.45	3.66	5.91
Iron	1,021	207.5	498.0	425.7	339.7	533.5	176.7	614.0
Lead	1.19	0.26	0.36	0.64	NC	NC	NC	0.74
Magnesium	3,118	2,227	2,789	2,110	2,444	2,246	2,704	2,726
Manganese	28.15	14.64	20.86	31.96	32.52	54.67	22.75	26.03
Mercury	NC	0.16	NC	NC	NC	NC	NC	NC
Molybdenum	NC	NC	NC	NC	NC	NC	NC	NC
Nickel	9.58	NC	NC	4.54	4.47	17.61	2.84	5.10
Selenium	1.18	1.24	1.29	1.50	1.24	1.66	1.04	1.24
Strontium	114.6	51.69	76.86	46.02	273.4	137.00	158.2	97.34
Vanadium	5.96	NC	NC	NC	NC	4.22	NC	3.74
Zinc	120.3	97.82	80.00	85.18	103.3	84.45	75.30	105.3
ORGANICS (mg/kg, wet weight)								
1,1 Biphenyl	NC	NC	NC	NC	NC	NC	NC	NC
4,4'-DDD	NC	0.05	0.01	0.02	NC	NC	0.03	0.02
4,4'-DDE	0.13	0.61	0.23	0.14	0.09	0.04	0.21	0.18
o,p'-DDE	NC	NC	NC	NC	NC	NC	NC	NC
4,4'-DDT	NC	0.02	NC	NC	NC	NC	NC	NC
BHC-delta	NC	NC	NC	NC	NC	NC	NC	NC
C1-Naphthalenes	NC	NC	NC	NC	NC	NC	NC	NC
C2-Naphthalenes	NC	NC	NC	NC	NC	NC	NC	NC
C3-Fluorenes	NC	NC	NC	NC	NC	NC	NC	NC
C3-Naphthalenes	NC	NC	NC	NC	NC	NC	NC	NC
C3-Phenanthrenes and Anthracenes	NC	NC	0.02	NC	NC	NC	NC	NC
C4-Naphthalenes	NC	NC	NC	NC	NC	NC	NC	NC
cis-Nonachlor	NC	NC	NC	NC	NC	NC	NC	NC
trans-Nonachlor	NC	0.03	NC	NC	NC	NC	NC	NC

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Table 4-12
Geometric Mean Concentrations of Contaminants in Seal Beach NWR Fish

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Chemical[a]	Species: Topsmelt	Deepbody Anchovy	Northern Anchovy	Goby	Killifish	Diamond Turbot	Queenfish	All Species
Naphthalene	NC	NC	NC	NC	NC	NC	NC	NC
PCB-1254	0.04	0.15	0.04	0.09	0.03	0.02	0.05	0.05
PCB-1260	NC	NC	NC	NC	NC	NC	NC	NC
PCB-TOTAL	0.04	0.17	0.04	0.09	0.04	0.02	0.05	0.05

NC = Geometric mean not computed because detected concentration occurred in fewer than half the samples.

Total PCB values are a sum of PCB-1254 and PCB-1260 values for any particular sample. PCB-1254 and PCB-1260 were the only PCBs identified in NWR biota samples. These PCBs are the only two that are typically found in biota. For deepbody anchovy and killifish, adequate detections occurred to allow computations of PCB-1254 and PCB-TOTAL geometric means, but not for PCB-1260. The minimal number of PCB-1260 values detected for these species (fewer than half the total) was used in the computation of PCB-TOTAL values, and therefore, resulted in PCB-TOTAL means that are slightly greater than the PCB-1254 means. The PCB-TOTAL geometric means shown in Table 4-12 are the means of summed values, not the sum of means.

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However, the highest concentrations of DDT, DDE, and PCBs were found in deepbody anchovy, the species with the greatest lipid content of the fish species analyzed (Table 4-7).

Spatial Patterns

Topsmelt was the only fish species collected in sufficient distribution and abundance throughout the NWR to characterize the spatial heterogeneity of fish tissue contamination. In general, the four POLB ponds at the ends of the east and west arms of the tidal saltmarsh were the areas from which samples yielded the highest contaminant concentrations. For heavy metals, Pond 3 had the greatest number of maximum concentrations (Table 4-10). The organochlorine compound maxima were most commonly seen in topsmelt samples from Pond 1 and sample location C-4.

Microtox® bioassays. Sediment with an EC_{50} (effective concentration at which the test organism's light output is decreased by 50 percent) of greater than 20,000 parts per million (ppm) (by sediment weight) is considered nontoxic. The closer the sample concentration is to zero, the more toxic the sediment. Using this criterion, all the tested sediments were toxic, and only those from locations C-1, G-1, and H-1 had values greater than 10,000 ppm, as shown on Table 4-13. Sediments from four sample locations (C-3, C-4, B-1, and B-2) had EC_{50} values lower than 1,000 ppm, indicating that they were the most toxic. Other stations were in the intermediate range of toxicity.

Statistical comparisons (using correlations) were used to test relationships between the Microtox® bioassay results and analytical results for sediments (both of which were converted to logarithms for statistical testing because of the distribution of values). The highest correlation was between toxicity and acid volatile sulfide ($r^2 = 0.723$). Table 4-14 indicates that, although there also was a significant correlation between toxicity and a few metals (zinc, copper, chromium, and nickel) or 4,4'-DDE, those relationships were much weaker than the one with sulfide, which occurs naturally in the sediments.

Among the four metals that were statistically correlated with toxicity, molar concentrations of sulfide always exceeded the molar concentration of metals, except for that of zinc at sample locations A-1, C-1, and C-2. (When molar concentrations of sulfide exceed those of metals, the metals are probably not toxic to benthic biota.) These three sample locations were among those with intermediate or low toxicity as measured by the Microtox® bioassays. Toxicity, therefore, is most attributable to sulfide concentrations, naturally occurring toxic compounds, rather than to the metals or organic contaminants of concern.

Least tern eggs. Concentrations of inorganic and organic chemicals detected in the least tern eggs are presented in Table 4-15.

Inorganics

Eight elements were measurable in all eggs analyzed for inorganics, whereas six others were found only in three or fewer eggs. Comparisons of geometric

Table 4-13
Ranking of EC_{50} Values for Sediments in Bioassays

Group No.[a]	Station No.	EC_{50} (ppm)
1	H-1	16,743
	C-1	13,622
	G-1	11,340
2	C-2	5,483
	D-2	5,036
	G-2	4,886
	F-1	3,832
	D-1	3,366
3	F-3	2,776
	D-3	2,295
	A-1	2,270
	E-4	2,158
	F-5	1,894
	E-1	1,851
	E-3	1,690
4	G-3	1,484
	F-2	1,282
	E-2	1,054
	F-4	1,014
5	B-2	937
	B-1	734
	C-4	468
	C-3	395

[a]Results are listed in ranked order and divided into the following subjectively defined groups (range in ppm): Group 1: 10,001-20,000; Group 2: 3,001-10,000; Group 3: 1,501-3,000; Group 4: 1,001-1,500; Group 5: 0-1,000.

Note: EC_{50} = Effective concentration at which the test organism's light output is decreased by 50 percent. (The closer the sample concentration is to zero, the more toxic the sediment, and values greater than 20,000 ppm are considered nontoxic.)

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Table 4-14
Relationship Between Toxicity Measured by Microtox® and Various Analytes

Analyte	R Square	Probability
Acid volatile sulfide	0.723	<0.00001
Zinc	0.394	<0.0014
Copper	0.297	<0.0072
Chromium	0.208	<0.0286
Nickel	0.172	<0.0494
Arsenic	0.022	<0.502
Lead	<0.001	>0.99
4,4'-DDE[a]	0.197	<0.0338

[a]Relationship highly dependent on a single high value for DDE.

Note: All analytes and toxicity values (EC_{50}) converted to logarithms.

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Table 4-15
Inorganic and Organic Chemicals Found in Least Tern Eggs Salvaged at Seal Beach NWR

Chemical	Measurable Concentrations[a]		
	N	Geometric Mean	Maximum
Inorganics (N=9)			
Aluminum	1	NC[b]	12.2
Arsenic	3	NC	0.735
Boron	9	8.37	21.8
Cadmium	2	NC	0.13
Copper	9	3.09	4.76
Iron	9	133	165.
Magnesium	9	455	555.
Manganese	9	Overall = 2.23 1991 = 2.02 1993 = 2.71	3.07
Mercury	9	0.82	1.26
Molybdenum	1	NC	2.32
Selenium	3	NC	2.71
Strontium	9	Overall = 4.17 1991 = 5.11 1993 = 2.77	6.36
Zinc	9	61.5	72.8
Organics (N = 11)			
4,4'-DDE	11	Overall = 3.65 1991 = 1.96 1993 = 5.19	6.98
PCB-1254	11	(0.99)	(2.03)
PCB-1260	1	NC	(0.25)
PCB-Total	11	(1.11)	(2.28)

[a]N = Number of samples with measurable concentrations. Inorganics reported as mg/kg dry weight; organics as mg/kg wet weight. Chemicals not listed were not measurable in any samples. Values shown in parentheses were estimated on the basis of moisture and lipid levels in the eggs.
NC = Not completed because chemical was measurable in less than half the samples.

Note: Means in different years are shown only for those analytes with statistically different means between years (t-test, $P<0.05$)

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means for the eight inorganics between years (1991 and 1993) indicate that only manganese and strontium were different between years (t-test, $P<0.05$). However, the two elements showed opposite trends between years (Table 4-15).

Organics

DDE and PCBs were the only organic chemicals found at measurable levels in the least tern eggs, and both DDE and PCB-1254 occurred at measurable levels in all eggs. Comparisons of geometric means for these two chemicals indicate that 4,4'-DDE was in higher concentration in least tern eggs in 1993 than in 1991 (t-test, $P<0.05$), while other analytes indicated no differences between years.

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5.0 DISCUSSION

This section summarizes the implications of the results from the watershed and land use evaluation, sediment transport evaluation, and sediment and biota contaminant analyses for assessing the status of contaminants in the NWR and the impacts of operations at NWS Seal Beach on the NWR.

5.1 Impacts of the POLB Ponds on Sediment Deposition and Erosion Patterns

The construction of the four POLB mitigation ponds at the landward ends of the west and east arms of the tidal saltmarsh in the NWR in 1990 has resulted in significant changes in sediment erosion and deposition in the NWR. The presence of the POLB ponds results in greater amounts of water pulled into the tidal saltmarsh during each tidal cycle (tidal prism) and higher current velocities in the tidal channels than was the case prior to their construction.

The increased tidal prism resulting from the construction of the POLB ponds also has increased intrusion of water from Anaheim Bay into the NWR tidal saltmarsh system. This results in significantly more water from Anaheim Bay flowing into the NWR during tidal exchange than was the case prior to the construction of the POLB ponds. Tidal exchange with Anaheim Bay is one potential source of contaminants into the NWR tidal saltmarsh system because runoff from virtually the entire urban Anaheim Bay watershed surrounding the NWR enters Anaheim Bay directly or from Bolsa Chica Channel and Huntington Harbour. EPA STORET data on water quality at sample points throughout the watershed indicate the potential for addition of contaminants to the NWR from this increased flow from Anaheim Bay. Additionally, stratification of the potentially contaminated freshwater (which is less dense than seawater) from the Bolsa Chica Channel over the seawater of Anaheim Bay would reduce mixing and dilution of this contaminated water with relatively "clean" ocean water, potentially resulting in greater concentrations of contaminants entering the NWR.

Surface runoff from a portion of the NWS subbasin discharges into the western arm of the tidal saltmarsh near the intersection of Kitts Highway and Bolsa Avenue. Agricultural runoff from the NWS discharges into the Bolsa Cell (north of Bolsa Avenue, south of railroad tracks [Figure 1-2]) of the NWR in an area that is connected hydraulically to the central arm of the NWR. Elevated contaminant concentrations identified in sediments and biota in and around the Bolsa Cell indicate possible contribution of contaminants from the NWS Seal Beach.

Based on State of California (1993) draft criteria for ranking toxic hot spots and the chemical analysis of sediments, the NWR could rank between low and moderate as a toxic hot spot. The area of potential concern for sediments is the northwest corner of the NWR, particularly at sample locations A-1, B-1, and C-3 where several metals were consistently elevated.

The impacts of the construction of the POLB ponds must be considered when evaluating the results of the sediment chemical analyses. Changes in the erosional and depositional characteristics in the tidal saltmarsh (as discussed in Subsection 4.2.2) can affect the distribution of contaminants in the NWR. Some areas that were not prone to erosion prior to the construction of the POLB ponds are now expected to experience erosion. For example, prior to the POLB pond construction, there was moderate potential for erosion in the lower two thirds of the west arm of the tidal saltmarsh. After POLB pond construction, velocities in the channel increased to the point that the entire length of the west arm below Bolsa Avenue has high erosion potential (see Figures 4-3 and 4-4). Additionally, in sample locations in areas that experienced deposition pre-POLB pond construction, invertebrates tended to have higher concentrations of chemicals (B-1, C-2, E-4, F-5, G-3). The result is that contamination in areas that are subject to increased erosion (such as B-1) could be reduced, while areas of deposition (the POLB ponds) could experience increased contamination.

Changes in the erosional and depositional characteristics of the tidal saltmarsh will result in a redistribution of sediments occurring over an unknown period of time. The time required for the transition from the pre-POLB pond to post-POLB pond conditions depends on the characteristics of sediments in the affected areas and coverage of the tidal channels by eel grass (which reduces erosion, but is, itself, susceptible to scouring by increased tidal velocities). It is possible that when samples for the NWR Study were taken in 1992, 2 years following the construction of the POLB ponds, sediment distribution was, and still may be, in flux. Therefore, sediment samples collected in 1992 may not reflect current or future sediment and contaminant distributions.

Areas of deposition indicated by the sediment transport evaluation include the POLB ponds, fish from which had elevated contaminant concentrations. Increased erosion appears to affect nearby sample locations (in particular, sample locations A-1 and B-1) in which sediment contaminant concentrations were elevated. Sediment sampling did not include POLB ponds because they had been recently excavated during construction.

5.2 Impacts of Contaminants on NWR Endangered Species

5.2.1 Chemicals of Potential Concern

Exposure of birds to environmental contaminants can be assessed by measuring concentrations in their food, water, air, or body tissues (Ohlendorf et al. 1978; Ohlendorf 1993). For the current study, the most directly applicable values are those for dietary exposure that are summarized in the USFWS Contaminant Hazard Reviews published by Eisler (1985 through 1993). Assessment values for inorganics available from that source, as well as those provided by Puls (1988) and the National Academy of Sciences (NAS) (NAS 1980), are presented in Table 5-1. Except for cadmium, copper, and lead levels given by Puls (1988), values from that source and those from NAS (1980) are based on poultry.

Effect levels in wild birds for many chemicals, and especially in environmentally realistic chemical forms and concentrations, have not been clearly established. For example, Eisler (1985a) states for cadmium that "Until other data become available, wildlife dietary levels exceeding 100 μg Cd/kg fresh weight on a sustained basis should be viewed with caution." However, feeding studies with mallards (*Anas platyrhynchos*) indicated that diets containing 200 mg Cd/kg produced no obvious deleterious effects after 13 weeks, although cadmium

Table 5-1
Assessment Values for Concentrations of Inorganics (mg/kg) in Bird Diets

Sheet 1 of 2

Element	Reference/Sources				
	Eisler[a] Acceptable	Puls[b]			National Academy of Sciences[c] Maximum Tolerable Level
		Normal/Adequate	High	Toxic	
Aluminum	NA	<500	NA	>1,500	200[d]
Arsenic[e]	<100 DW[f]	100[f]	NA	NA	100[f]
Barium	NA	NA	NA	NA	(20)[d]
Boron	<13 FW	NA	NA	NA	(150)
Cadmium	<0.1 FW	<5	10 - 20	>20	0.5[g]
Chromium	<10 DW	5 - 20	NA	>300	1,000
Copper	NA	10 - 50	100 - 200	>200	300
Iron	NA	80	NA	200 - 2,000	1,000
Lead	<10 DW	NA	25[h]	NA	30[g]
Magnesium	NA	600 - 3,000	3,000 - 9,000	6,400 - 12,800	(3,000)
Manganese	NA	60 - 200	1,000 - 4,000	>4,000	2,000
Mercury	<0.1 FW	<0.1	1 - 50	5 - 100	2[g]
Molybdenum	<200 DW	0.03 - 1.0	3 - 10	>200	100
Nickel	NA	0.1 - 3.0	100 - 300	700 - 1,000	300
Selenium	<6 DW[i]	0.3 - 1.1	3 - 5	>5	2

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Table 5-1
Assessment Values for Concentrations of Inorganics (mg/kg) in Bird Diets

Sheet 2 of 2

Element	Reference/Sources				
	Eisler[a] Acceptable	Puls[b]			National Academy of Sciences[c] Maximum Tolerable Level
		Normal/Adequate	High	Toxic	
Silver	NA	10 - 100	100	NA	100
Strontium	NA	NA	NA	>3,000	3,000
Vanadium	NA	0.1 - 3.0	6 - 50	100 - 800	10
Zinc	<178 DW	98 - 200	800 - 2,000	>2,000	1,000

[a]Eisler, 1985a, 1985b, 1986a, 1987a, 1988a, 1988b, 1989, 1990a, 1993.
[b]Puls, 1988; all values given as DW for poultry or waterfowl (when available).
[c]NAS, 1980; all values given as DW for poultry; values in parentheses were extrapolated from other species.
[d]As soluble salts of high bioavailability. Higher levels of less soluble forms found in natural substances can be tolerated.
[e]Based also on Phillips, 1990, and Stanley et al., 1994.
[f]Arsenic in organic form, which is less toxic than inorganic arsenic.
[g]Level based on human food residue considerations.
[h]Maximum no effect level for waterfowl.
[i]Based also on Ohlendorf, 1989, and USDI, 1993.

DW = Dry weight
FW = Fresh weight
NA = Not available

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had accumulated to high levels in the ducks' kidneys. Species differences in sensitivity to various chemicals measured in the current study are unknown.

Therefore, the values used for assessment of analytical results are generally the more conservative ones. For each chemical of potential concern, a final assessment value (generally the No Observed Effect Level [NOEL] or a comparable value) was selected for comparison with observed concentrations in invertebrates or fish (Table 5-2). Maximum observed concentrations compared to assessment values are considered to be the most conservative indicators of potential adverse effect to the endangered least tern and clapper rail. Assessment of the potential toxicity of contaminants of concern in the NWR has been evaluated based on collected food-chain species eaten by these birds, but applies to other bird species in the NWR with comparable diets.

Further comparisons for rail diets were made by comparing the maximum mean for the combined three species of invertebrates at an individual sample location (potentially representing the diet of a rail in a localized home range) to the assessment values (Table 5-2). For tern diets, the maximum mean for an individual fish species (across all sample locations because terns would likely feed in several areas within the NWR) was compared for each chemical to the assessment. The comparisons are considered to be representative of potential exposures for rails and terns because they reflect the likely feeding patterns of the two species.

Inorganics

Aluminum. The chronic toxicity of aluminum is low (Scheuhammer 1987) and, like many of the other inorganics, its toxicity depends greatly on the chemical form found in the diet. Toxicity of aluminum also depends on the dietary levels of other elements (e.g., calcium and phosphorus) available to the birds. As noted in Tables 5-1 and 5-2, the maximum tolerable level (MTL) for aluminum given by NAS (1980) is based on soluble salts of high bioavailability, but higher levels of less soluble forms found in natural substances can be tolerated. Because of its expected low toxicity to birds, aluminum is not considered a COC for clapper rails and least terns at the NWR.

Arsenic. Arsenic consistently occurred in invertebrates and fish collected in the NWR at concentrations that were much lower than the maximum dietary levels considered acceptable for birds (Tables 4-8, 4-11, and 5-1). Thus, arsenic is not considered a COC for clapper rails and least terns at the NWR.

Barium. Barium is similar to aluminum in that the MTL given by NAS (1980) for poultry is based on highly bioavailable soluble salts (Table 5-1). The maximum detected concentrations of barium in invertebrates and fish in the NWR were approximately equal to that MTL. Because this barium is probably much less bioavailable than those inorganic forms, barium is not considered a concern for clapper rails and least terns at the NWR.

Table 5-2. Toxicity Assessment Values (NOELs) and Ratios to Observed Values in Food Organisms

						Maximum Observed Values				Maximum Mean for Three Species o Invertebrates at an Individual Station		Maximum Mean of Individual Fish Species Across all Stations	
						Rail Food: Invertebrates		Tern Food: Fish					
Chemical Inorganics	Literature Assessmen Value	Weight basis	Final Assessment Values (DW)	Qualifier	Assessment Based On (1)	Maximum (DW)	Ratio (Maximum: ssessment	Maximum (DW)	Ratio (Maximum: ssessment	Maximum Mean (DW)	Ratio (Maximum Mean: Assessment)	Maximum Mean (DW)	Ratio (Maximum Mean: Assessment)
Aluminum	200	DW	200	A	NAS Max.tolerable	9200	46.00	3860	19.30	1336.00	6.68	929.50	4.65
Arsenic	100	DW	100	B	Eisler:"acceptable"	29.5	0.30	4.68	0.05	3.64	0.04	3.35	0.03
Barium	20	DW	20	A	NAS Max.tolerable	13.4	0.67	20.1	1.01	7.30	0.37	5.97	0.30
Boron	13	FW	52		Eisler:"acceptable"	18.7	0.36	107	2.06	12.20	0.23	24.28	0.47
Cadmium	0.1	FW	0.4	C	Eisler:"acceptable"	0.89	2.23	0.25	0.63	0.38	0.94	0.14	0.34
Chromium	10	FW	40		Eisler:"acceptable"	13.3	0.33	71.2	1.78	11.50	0.29	27.55	0.69
Copper	50	DW	50		Puls, Adequate-Hig	363	7.26	16.2	0.32	30.80	0.62	10.80	0.22
Iron	80	DW	1000		NAS Max.tolerable	10200	10.20	4220	4.22	1426.00	1.43	1021.00	1.02
Lead	10	DW	10		Eisler:"acceptable"	148	14.80	7.78	0.78	2.64	0.26	1.19	0.12
Magnesium	3000	DW	3000		Puls, Adequate-Hig	12100	4.03	4020	1.34	6778.00	2.26	3117.00	1.04
Manganese	200	DW	200		Puls, Adequate-Hig	214	1.07	113	0.57	148.40	0.74	54.70	0.27
Mercury	0.1	FW	0.4		Eisler:"acceptable"	0.56 **	1.40	0.26	0.65	0.56**	1.40	0.16	0.40
Molybdenum	200	DW	200		Eisler:"acceptable"			110	0.55			18.20	0.09
Nickel	100	DW	100		Puls, Adequate-Hig	9.35	0.09	44.5	0.45	3.20	0.03	17.60	0.18
Selenium	6	DW	6	D	Eisler:"acceptable"	2.97	0.50	2.71	0.45	1.14	0.19	1.66	0.28
Silver	100	DW	100		NAS Max.tolerable	0.73	0.01			0.73	0.01		
Strontium	3000	DW	3000		NAS Max.tolerable	2130	0.71	349	0.12	1347.00	0.45	273.40	0.09
Vanadium	10	DW	10		NAS Max.tolerable	9.42	0.94	10.4	1.04	7.77	0.78	6.26	0.63
Zinc	178	DW	178		Eisler:"acceptable"	542	3.04	147	0.83	113.00	0.63	120.30	0.68

Organic Compounds						Rail food: Invertebrates		Tern food: Fish		Invertebrates		Fish	
			Assessment Values (FW)		Assessment Based On (2)	Invertebrate Maximum (FW)	Ratio (Maximum: ssessment	Fish Maximum (FW)	Ratio (Maximum: ssessment	Maximum (FW)	Ratio (Maximum: Assessment)	Maximum (FW)	Ratio (Maximum: Assessment)
DDE	0.05	FW	0.05		NAS	0.05	1.00	1.58	31.60	0.036	0.72	0.62	12.40
PCBs	0.50	FW	0.50		NAS	0.61	1.22	0.74	1.48	0.099	0.198	0.17	0.34

DW = dry weight
FW = fresh weight
DDE = 1,1-dichloro-2,2-bis (4 chlorophenyl) ethene
PCB = Polychlorinated biphenyls
MTRL = Maximum Tissue Residue Levels
* FW Assessment values multiplied times 4 to yield estimate of DW value (assuming 75 percent water)
** Figure represents value for horned snail only, thus mean and maximum are equal.
(1) See Table 5-1 for references and further explanation of assessment values.
(2) See Table 5-4 and text for further explanation of assessment values. NAS guideline for total DDT and total PCB in whole fish used for assessment.
Shaded ratios show cases where mean concentration of at least one species exceeded assessment value.

QUALIFIERS:

A Soluble salts of high bioavailability. Higher natural levels may be tolerated.
B Arsenic in organic form, which is less toxic than inorganic arsenic.
C Cadmium value is conservative- see text for further discussion.
D Based on Ohlendorf, 1989 and USDI, 1993.

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Boron. Maximum concentrations of boron in algae, invertebrates, and fish were similar to the maximum dietary concentrations considered acceptable for birds (Tables 5-1 and 5-2). However, these maximum detected concentrations were also similar to the geometric mean boron concentrations found in aquatic plants, invertebrates, and fish at the Volta Wildlife Area located in the San Joaquin Valley; (Schuler, 1987; Hothem and Ohlendorf, 1989), where reproductive success of aquatic birds was normal (Ohlendorf et al., 1989). Mean boron in invertebrates at all sample locations and mean boron levels in all fish species were lower than the assessment level. Therefore, boron is not expected to cause adverse effects in clapper rails and least terns at the NWR.

Cadmium. Maximum concentrations of cadmium in invertebrates (0.89 mg/kg dry weight) were slightly higher than the dietary level of concern put forth by Eisler (1985a), but the maximum in fish and individual sample location means for invertebrates were lower (Table 5-2). Based on studies with mallards, cadmium does bioaccumulate in some bird tissues, but the threshold dietary levels for adverse effects are not well known (White and Finley, 1978; White et al., 1978; Cain et al., 1983). Although cadmium at the average levels found in invertebrates probably would not adversely affect birds that consume invertebrates at the NWR, it is considered a COC because of its potential toxicity.

Chromium. Chromium concentrations in invertebrates (Table 4-8) and fish (Table 4-11) sometimes exceeded the dietary concentrations considered by Eisler (1986a) to be acceptable for birds (Table 5-1). The geometric mean chromium concentrations in turbot (27.5 mg/kg) and topsmelt (14.0 mg/kg), as well as all fish species combined (10.1 mg/kg) (Table 4-12), were at or above that level, although most were within the normal/adequate range for poultry (Puls, 1988) and all were below the MTL for poultry (NAS, 1980). Eisler (1986a) also states, "*...available evidence suggests that organs and tissues of fish and wildlife that contain >4.0 mg total Cr/kg dry weight should be viewed as presumptive evidence of chromium contamination.*" The geometric means for chromium in horned snails (11.6 mg/kg) and saltmarsh snails (11.4 mg/kg) (Table 4-9) also slightly exceeded the 10 mg/kg value given by Eisler (Table 5-1). Thus, chromium is considered a COC for clapper rails and least terns at the NWR.

Copper. The toxicological significance of copper in diets of wild birds is not clear, but concentrations exceeding 200 or 300 mg/kg in poultry diets are considered toxic or excessive (Table 5-1). Maximum copper concentrations in most invertebrates and fish were in the normal/adequate range or between that and high dietary levels for poultry. Maximum copper concentrations in crabs were within the high range and those in ghost shrimp exceeded the toxic and MTL values for poultry. However, mean values within and across sample locations did no exceed assessment values (Table 5-2). Comparable values for ghost shrimp from other California locations are similar to Seal Beach concentrations (Jenkins 1980). In addition, data for seabirds indicate that copper levels in bird tissues are regulated (Furness and Rainbow 1990) and toxicity is probably unlikely. Therefore, direct toxicity of copper to clapper rails and least terns at the NWR is not considered to be of concern.

Iron, Magnesium, Manganese. Iron, magnesium, and manganese are essential nutrients in animal diets that have low toxicity to poultry (Table 5-1). Their occurrence in marine ecosystems is largely the result of natural rather than anthropogenic causes, and concentrations in bird tissues are physiologically regulated (Furness and Rainbow 1990). Thus, they are not considered COCs for clapper rails and least terns at the NWR.

Lead. Lead concentrations in polychaetes (Table 4-8) reached levels several times higher than those considered by Eisler (1988b) to be acceptable in bird diets, high for waterfowl diets by Puls (1988), and the MTL for poultry (Table 5-1). Consequently, lead is considered a COC based on individual sample maxima. However, mean concentrations in diet items that more closely approximate exposure do not exceed the assessment value (Table 5-2).

Mercury. Mercury was seldom detected in biota samples, and the maximum concentration was less than 0.5 mg/kg wet weight, which slightly exceeds the assessment value (Table 5-2). This low level of mercury in the NWR biota is reflected by the low concentrations found in clapper rail eggs analyzed separately by the USFWS (Schwarzbach, 1994). Mercury is not a COC at the NWR.

Molybdenum. Molybdenum was not detectable in invertebrates and the concentrations found in fish and algae were lower than those that are considered harmful for birds (Tables 5-1 and 5-2). The highest mean concentration for a fish species was less than 0.1 of the assessment value. Thus, molybdenum is not considered a COC.

Nickel. Nickel concentrations in invertebrates, algae, and fish were elevated in comparison to the normal/adequate dietary range for poultry (Puls, 1988), although they were below the high range and less than the MTL and appropriate assessment values (Tables 5-1 and 5-2). Data available for seabirds imply that the birds do not metabolically regulate tissue concentrations of nickel (Furness and Rainbow, 1990), so it is considered a COC.

Selenium. Selenium concentrations (whether maxima or means) in biological samples were well below the dietary levels associated with adverse effects in wild birds (Tables 5-1 and 5-2). Research on selenium effects in aquatic birds conducted by USFWS during the past 10 years (Ohlendorf 1989, 1995) suggests that the concentrations in invertebrates and fish at the NWR are unlikely to affect birds at the NWR, although maximum concentrations sometimes exceed the MTL for poultry (Table 5-1). Consequently, selenium is not a COC for clapper rails and least terns at the NWR.

Silver. Silver was rarely detectable in biota samples and concentrations were low in comparison to available assessment values (Table 5-1). Thus, it is not considered a COC at the NWR.

Strontium. No assessment values are available from the USFWS Contaminant Hazard Reviews (Eisler 1985 through 1993) or from Furness and Rainbow (1990). Strontium occurred at maximum concentrations in biota well below the levels that are harmful to poultry, and the ratios of means for invertebrates (0.45) or fish (0.09) to assessments also were low (Tables 5-1 and 5-2). Therefore, it is not considered a concern for clapper rails and least terns at the NWR.

Vanadium. Vanadium sometimes occurred in biota at maximum concentrations considered high or somewhat above the MTL for poultry (Tables 5-1 and 5-2). However, assessment values for vanadium in the diets of wild birds are not available and highest mean concentrations in invertebrates at any sample location or fish across all sample locations were well below the assessment value (Table 5-2). It is an essential element for marine organisms, and they have evolved mechanisms to sequester, transport, and use the vanadium to which they are exposed (Furness and Rainbow 1990). Although the assimilative capacity of the system can be overloaded by localized excessive levels, effects are not easily demonstrated. When vanadium was fed to mallards at 100 mg/kg for 12 weeks, there was no apparent effect on their health (White and Dieter 1978). Lipid metabolism of laying hens receiving the treated diet was altered, but their body weights were comparable to controls and they appeared healthy throughout the study. Hence, vanadium is not considered a concern for clapper rails and least terns at the NWR.

Zinc. Zinc occurred at highest concentrations (up to 542 mg/kg) in saltmarsh snails (Table 4-8). This concentration exceeds the normal/adequate range given by Puls (1988) and that listed by Eisler (1993) as "excessive" for poultry. All other samples had zinc concentrations in the normal/adequate range for poultry. In addition, mean concentrations approximating exposure did not exceed assessment levels (Table 5-2). Dietary concentrations for zinc-poisoned mallards were 2,500 to 3,000 mg/kg (Eisler 1993), which is similar to toxic levels for poultry (Table 5-1). It is unknown whether the zinc concentrations found in saltmarsh snails are typical for that species elsewhere, but the concentrations in saltmarsh snails were several times higher than those in horned snails. This suggests that saltmarsh snails may naturally have higher tissue concentrations than the other sampled species. As with copper, zinc is an essential element for marine organisms and levels are likely to be closely regulated (Furness and Rainbow 1990). Although the concentrations found in food-chain biota are probably not toxic to birds at the NWR, zinc is considered as a COC because of its possible relationship to toxicity as indicated by the Microtox® bioassay.

Organics

Pesticides, PCBs, and PAHs. Organochlorine contaminants such as DDT and its metabolites (primarily DDE and DDD), PCBs, and chlordane have a tendency to bioaccumulate to high levels in birds that consume contaminated organisms (Stickel 1973; Ohlendorf et al. 1978; Eisler 1986b, 1990b). In contrast, PAHs generally show little tendency to bioaccumulate in food chains, despite their high lipid solubility, probably because most PAHs are rapidly metabolized (Eisler 1987b). Based on the frequency of occurrence, maximum and mean concentrations, potential to bioaccumulate, and known effects of these various organics in birds, DDE is the chemical considered most likely to cause potential effects in birds at the NWR.

Dietary concentrations used for assessment of some organic contaminants in bird diets also are provided by Eisler (1986b, 1990b) and by other reviews (Stickel 1973; Ohlendorf et al. 1978), although effect levels in clapper rails and least terns are not known. In general, dietary concentrations of 3 mg/kg (fresh weight) of either DDE or PCBs are considered to cause adverse effects in birds. Dietary concentrations up to 0.3 mg/kg (fresh weight) total chlordane are considered acceptable. Acute and chronic toxicity effects on birds exposed to PAHs in their diet are very limited (Eisler 1987b). When mallards were fed diets containing 4,000 mg PAHs/kg (mostly as naphthalenes, naphthenes, and phenanthrene) for a period of 7 months, no mortality or visible signs of toxicity were observed, but the birds did show physiological responses (including 25 percent larger livers than controls).

The USFWS has periodically determined concentrations of selected inorganic and organochlorine chemicals in freshwater fish collected from a nationwide network of randomly located stations as part of the National Contaminant Biomonitoring Program (NCBP) (Schmitt and Brumbaugh 1990; Schmitt et al. 1990). Chemical concentrations in the NCBP are typically reported on a wet-weight basis. Average moisture content of the fish is about 75 percent;

thus, wet-weight concentrations can be converted to approximate dry-weight concentrations through multiplying by a factor of 4. Results of the most recently published NCBP survey are summarized in Table 5-3 for comparison with results from the NWR.

Comparing the concentrations of various chemicals in fish from the NWR with those found in the NCBP (Table 5-3) suggests that cadmium, mercury, selenium, DDD, DDT, PCBs, cis-nonachlor, and trans-nonachlor concentrations are similar. Such a comparison also shows that copper, lead, and zinc maximum concentrations in at least some fish species from the NWR exceed the NCBP 85th percentile values and geometric means exceed the NCBP geometric means. Therefore, these three metals are potentially present at levels above background and retained as COCs although the higher levels in estuarine fish from the NWR may be related to species differences. Schmitt et al. (1990) do not provide 85th percentile values for fish in the NCBP, but the geometric mean DDE concentrations in deepbody anchovy, northern anchovy, and queenfish are equal to the NCBP geometric mean or higher than that value. Although arsenic concentrations in fish from the NWR are higher than the NCBP values, this is not unexpected. Marine organisms normally contain arsenic concentrations of several to more than 100 mg/kg dry weight, but these levels present little hazard to the organism or its consumers (Eisler 1988a).

NAS has established recommended maximum concentrations of certain toxic substances in freshwater fish and marine fish tissue to protect the fish

Table 5-3
Geometric Mean Concentrations (mg/kg wet weight), 85th Percentile (for Inorganics) and Maximum Concentrations Found Nationwide in Freshwater Fish by the National Contaminant Biomonitoring Program, 1984

Chemical	Geometric Mean	85th Percentile	Maximum Concentration
Inorganic[a]			
Arsenic	0.14	0.27	1.50
Cadmium	0.03	0.05	0.22
Copper	0.65	1.0	23.1
Lead	0.11	0.22	4.88
Mercury	0.10	0.17	0.37
Selenium	0.42	0.73	2.30
Zinc	21.7	34.2	118.4
Organics[b]			
4,4'-DDE	0.19	--	4.74
4,4'-DDD	0.06	--	2.55
4,4'-DDT	0.03	--	1.79
PCB 1254	0.21	--	4.0
PCB 1260	0.15	--	2.3
cis-Nonachlor	0.02	--	0.45
trans-Nonachlor	0.03	--	1.0

[a]Schmitt and Brumbaugh, 1990; average moisture content of fish was about 75% (thus, wet-weight concentrations can be converted to approximate dry-weight concentrations by multiplying by 4).
[b]Schmitt et al., 1990; only those chemicals detected in fish at Seal Beach NWR are included.

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containing those chemicals, as well as to protect animals that consume the contaminated fish (NAS 1973). These recommended guidelines are presented in Table 5-4 and should reflect levels protective for least terns as well as clapper rails feeding on invertebrates. Consequently, the NAS values were selected as final assessment values for evaluation of exposure (Table 5-2).

Additional criteria or standards have been published by the Food and Agriculture Organization of the United Nations (Nauen 1983) and by the U.S. Food and Drug Administration (USFDA 1994). However, those values are for contaminant concentrations in edible portions of fish and are not directly applicable to the (whole-body) results or purposes of this study.

Maximum detected concentrations of mercury and total BHC in fish from the NWR were less than the NAS guideline levels for whole freshwater or marine fish. Maximum total chlordane (cis nonachlor plus trans nonachlor) concentration was lower than the guideline for freshwater fish but higher than that for marine fish. Maximum concentrations of total DDT and total PCBs exceeded the recommended guidelines in Table 5-4, although PCBs were only slightly higher than the guideline.

Contaminant concentrations in fish and in mussels from California waters are measured periodically through the Toxic Substances Monitoring Program (TSMP) or the California State Mussel Watch (CSMW) (Phillips 1988; Rasmussen 1992). Those programs use "elevated data levels" (EDLs) as internal comparative measures that rank a given concentration of a particular substance with previous data from the TSMP or CSMW. The EDLs are calculated by ranking all of the results for a given chemical from the highest concentration to the lowest concentration measured (including those not detected). From this, a cumulative distribution is constructed and percentile rankings are calculated. The 85th percentile (EDL 85) is used as an indication that a chemical is elevated from the median. EDL 85 values for selected organisms and chemicals of interest in the NWR study are shown in Table 5-5.

Although species sampled at the NWR are different from those sampled in the TSMP and CSMW and some of the TSMP and CSMW stations are intentionally placed in contaminated areas. The EDL 85 values are useful for evaluating results from the NWR. Data for marine fish sampled in the TSMP are inadequate for calculation of EDL values in whole fish, but values are available for freshwater fish.

The State of California (1993) also has developed Maximum Tissue Residue Levels (MTRLs) for evaluating contaminant concentration in organisms as an element of the Bay Protection and Toxic Cleanup Program (BPTCP). The MTRLs are calculated by multiplying the human health water quality objective in the appropriate statewide draft plan by the chemical's bioconcentration factor. Exceedance of MTRLs by toxic chemicals in tissues of resident organisms is given in the BPTCP as one of the conditions that may indicate the site is a "potential hot spot" (as defined by State of California, 1993). Table 5-5 lists the available MTRLs for contaminants found in the biological samples from the NWR. However, because of various uncertainties in the calculation of MRTLs

Table 5-4
NAS Guideline Levels for Toxic Chemicals in Whole Fish
(mg/kg wet weight)

Chemical	NAS[a] Recommended Guidelines	
	Freshwater Fish	Marine Fish
Mercury	0.5	0.5
DDT (total)	1.0	0.05
PCB (total)	0.5	0.5
Chlordane (total)	0.1[b]	0.05
Benzene hexachloride (total)	0.1[b]	0.05

[a]NAS, 1973.
[b]Individually or in combination, including various isomers and component chemicals.

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Table 5-5
Elevated Data Levels (EDL 85s) for Inorganic and Organic Chemicals in the Toxic Substances Monitoring Program (TSMP) and California State Mussel Watch (CSMW)

Chemical	TSMP[a] Freshwater Fish	CSMW[b] California Mussels	BPTCP[c] Estuarine Organisms
Inorganics			
Aluminum	NA	662.8	NA
Arsenic	0.48	23.82	NA
Cadmium	0.10	10.83	NA
Chromium	0.20	3.93	NA
Copper	3.28	21.85	NA
Lead	0.28	11.01	NA
Manganese	NA	34.23	NA
Mercury	0.07	0.44	1.0
Nickel	0.20	5.30	220
Selenium	1.50	4.48	NA
Silver	0.03	0.70	NA
Zinc	35.0	336.3	NA
Organics			
4,4'-DDE	2,295.0	NA	32
4,4'-DDD	386.0	NA	NA
4,4'-DDT	193.0	85.5	NA
Total DDT	3,704.0	1,483.0	32
PCB 1254	175.0	1,420.0	NA
PCB 1260	110.0	LT	NA
Total PCB	281.5	1,420.0	2.2
cis-Nonachlor	20.6	NA	NA
trans-Nonachlor	55.7	NA	NA
Total Chlordane	171.7	192.4	1.2
delta-Benzene hexachloride	<5.0	LT	NA
Hexachlorobenzene	7.3	0.17	6

[a]Rasmussen, 1992; values for inorganics are mg/kg wet weight in whole fish, those for organics μg/kg wet weight.
[b]Phillips, 1988; values are mg/kg dry weight for inorganics, μg/kg dry weight for organics.
[c]State of California, 1993; values are mg/kg for inorganics, μg/kg for organic (presumably both are on wet-weight basis although not specified and could not be confirmed)

ID = Insufficient data to calculate an EDL
LT = EDL is less than the detection limit
NA = Not available

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(such as the use of human health water quality objectives), they are not considered directly applicable for bird exposures.

Comparing concentrations of chemicals detected in fish from the NWR with those from the TSMP indicates that concentrations of cadmium, mercury, selenium, DDE, DDD, DDT, cis-nonachlor, trans-nonachlor, BHC, and hexachlorobenzene concentrations at the NWR are not unusual (as are those for arsenic as noted above in comparison to freshwater fish in the NCBP).

Concentrations of chromium, copper, lead, nickel, zinc, and PCBs in fish at the NWR appear elevated in comparing the maximum detected concentrations there with EDL 85 values from the TSMP. Values presented in Table 5-5 from the CSMW will be discussed later in Other Studies in comparison to results of CSMW sampling in Anaheim Bay.

Maximum detected concentrations of mercury and nickel (the only two inorganics for which MTRLs are available) in all biological samples from the NWR were below the MTRLs (Tables 4-8, 4-11, and 5-5). However, maximum concentrations of DDE in snails and crabs were near or slightly above the MTRL, and geometric means (Table 4-12), as well as maximum concentrations of DDE in each of the fish species (Table 4-11) exceeded the MTRL. Maximum concentrations of PCBs in saltmarsh snails, crabs, and clams (Table 4-8) exceeded the MTRL for total PCBs (Table 5-2). Maximum and geometric mean PCB concentrations in each fish species (Tables 4-11 and 4-12) also exceeded the MTRL (Table 5-5). Geometric means for other chemicals were below the MTRLs.

In summary, the following chemicals appear to be elevated in invertebrates or fish from the NWR in comparison to various toxicological effect values or reference values:

- o Cadmium
- o Chromium
- o Copper
- o Lead
- o Nickel
- o Zinc
- o DDE
- o PCBs

These chemicals are, therefore, identified as being of potential concern for possible effects in clapper rails and least terns or their diets at the NWR.

Spatial Patterns

Overall patterns in the occurrence of various COCs (six inorganics, two organics) were examined by comparing the locations where they occurred at highest concentrations in the most widely collected species. (Refer to Figure 3-2 for sample locations in the NWR.) Those species included horned snails, saltmarsh snails, striped shore crabs, and topsmelt. Although topsmelt were not collected at each of the 23 sample locations, they were collected at least once at 9 sample locations and at least three times in each of the POLB mitigation ponds as shown on Figure 5-1. Topsmelt also are more mobile than are the invertebrates sampled in this study, so they may not be as reliable indicators of locations-specific exposure. Nevertheless, the evaluation did indicate that topsmelt often had highest concentrations of contaminants at the same general locations where some of the invertebrates had highest levels.

The three locations for each species where concentrations of selected contaminants were highest were listed in Table 4-10. The areas that most often had among the highest concentrations of inorganics were sample locations B-1 and C-1, E-4, G-3, and the combined area of sample location F-5 and Pond 3 (Table 4-10). Sample location G-2 had highest concentrations of lead in both horned and saltmarsh snails. Inorganics in horned snails from sample location D-2 were often among the five highest concentrations for that species. The crabs from sample location H-1 often had among the five highest chemical concentrations for that species, but were among the three highest only for copper (Table 4-10). However, horned and saltmarsh snails from sample location H-1 were seldom found to have the highest concentrations for inorganic chemicals.

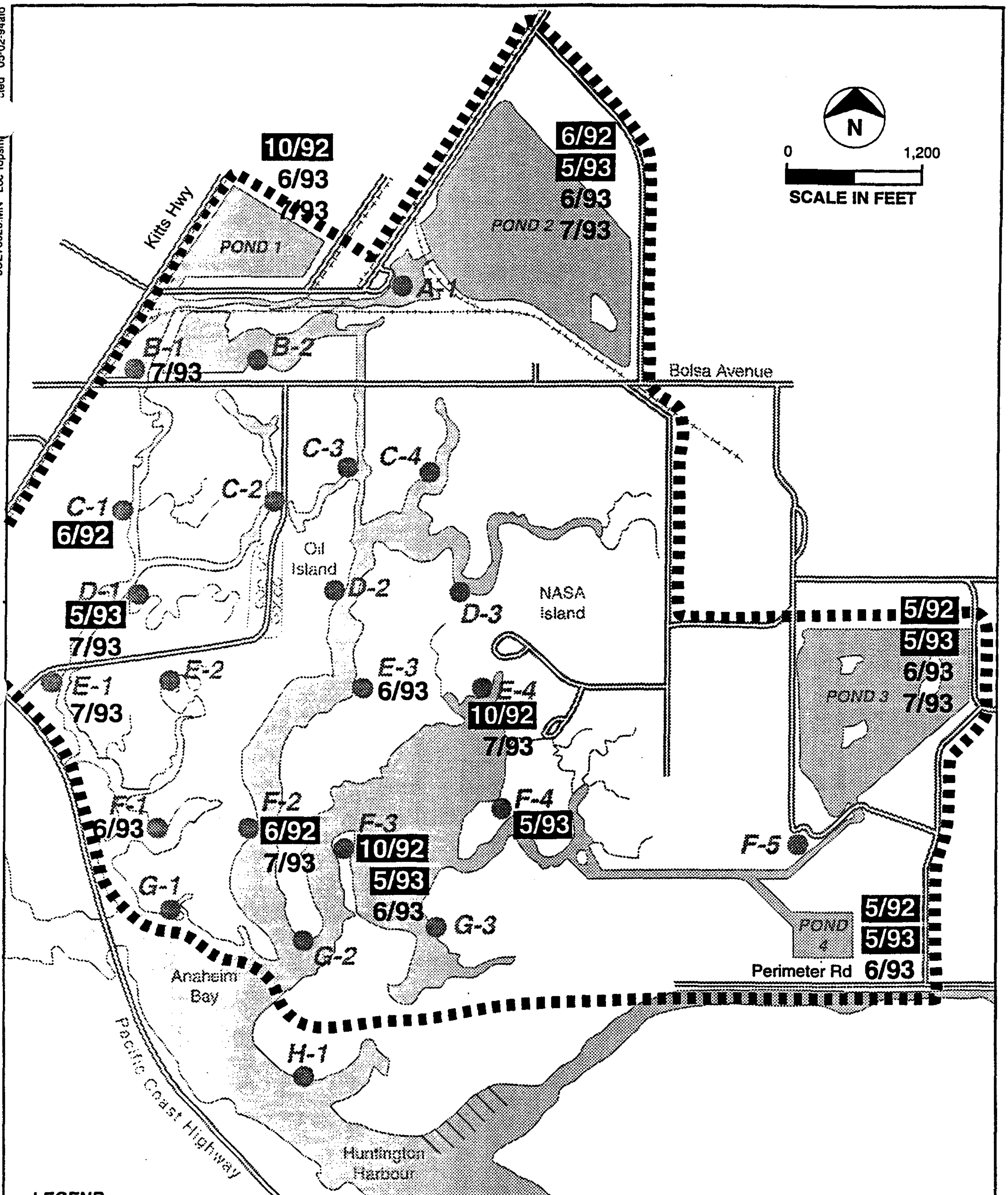
Within species, the following sample locations were areas where inorganic concentrations were generally higher:

- o Horned snails—D-2, D-3 and B-1
- o Saltmarsh snails—G-3 and E-4
- o Shore crabs—B-1, F-5, and E-4
- o Topsmelt—Pond 3

Although the highest and second-highest concentrations of inorganics within a particular species sometimes occurred at adjacent or nearby sample locations (for example, zinc in horned snails from sample locations D-2 and D-3, or lead in that species from sample locations G-2 and H-1), this was unusual. Most often, the spatial patterns within species were unclear and it was more useful to consider the patterns for all invertebrate species combined with topsmelt. In doing so, concentrations for each metal appear to be generally higher at the following areas (invertebrates and fish often were not collected at the same sample locations, ponds are combined with adjacent sample locations):

- o Cadmium—A-1 and Pond 2, B-1, C-1, F-5 and Pond 3
- o Chromium—B-1, E-1, E-4, and Pond 3
- o Copper—E-4, F-5 and Pond 3, G-3
- o Lead—E-4, F-1, G-2, Pond 3
- o Nickel—No particular pattern
- o Zinc—F-5 and Pond 3 (otherwise, widely scattered sample locations)

Comparing the invertebrate patterns with those observed in the NWR sediments, the strongest similarities occur for the general area of sample location B-1 where metals such as cadmium, chromium, copper, and lead were



LEGEND:

5/93 Analyzed for organics; others analyzed only for inorganics

NWR Boundary

FIGURE 5-1
LOCATIONS AND SAMPLING TIMES WHEN TOPSMELT WERE COLLECTED, 1992 AND 1993
AT SEAL BEACH NWR

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generally elevated. However, the only statistically significant relationship by sample location between sediment and biota metals was for chromium in saltmarsh snails ($P<0.05$). Although the chromium relationship is statistically significant, only a small portion of the variation in saltmarsh snail chromium can be explained by variation in sediment chromium ($r^2=0.2$).

Among the two organic COCs, spatial patterns were more apparent for DDE than for PCBs. Higher concentrations of DDE occurred in POLB Ponds 1 and 2 fish and in sample locations A-1 and B-1 invertebrates (Table 4-10). When DDE concentrations in sediments were normalized for total organic carbon concentration (a standardization for bioavailability; see Appendix C), they were highest at sample locations B-1 and H-1, and significantly correlated to variation in concentrations in crabs ($P<0.01$, $r^2=0.9$).

PCBs were not detected as frequently as DDE and there were fewer similarities among species in which the highest concentrations occurred. Although both horned and saltmarsh snails from sample location E-3 had highest PCB concentrations for those species, the second highest levels for horned and saltmarsh snails and the highest concentrations for crabs and topsmelt were spatially disjunct (at F-1 and B-2, and D-1 and Pond 4, respectively). Sample location F-1 was the only other location where two species had concentrations among the five highest for two species (horned snail and saltmarsh snail). PCBs in sediments were detected only at sample location C-3, which was not among the highest sample locations for snails, crabs, or topsmelt.

Bird Eggs

Bird eggs can be good indicators of previous or current exposure of the female that laid them to some inorganics (such as mercury and selenium) and to organochlorines (Ohlendorf et al. 1978; Ohlendorf 1993). However, for some chemicals of potential concern at the NWR (such as cadmium and lead), there is little relationship between the female's dietary exposure and the concentrations found in the eggs. Furthermore, some chemicals (including mercury and organochlorines) that are passed on to eggs may represent body burdens accumulated by the female over long periods, including exposure in previous years and in overwintering locations. Taking these various factors into consideration leads to the following conclusions:

- Inorganics for which interpretive guidelines are available generally were present at background levels, except mercury exceeded 1 mg/kg in one egg collected during 1993.

- DDE occurred in some eggs (especially during 1993) at levels associated with impaired reproduction in sensitive species (although effect levels in least terns are not well known).

- Concentrations of PCBs in all eggs were less than the concentration (<16 mg/kg fresh weight) recommended by Eisler (1986b) as a proposed criterion for protection of birds.

Mercury concentrations in the least tern eggs were similar to or lower than those in Forster's tern (*Sterna forsteri*) and Caspian tern (*Sterna caspia*) eggs from San Francisco Bay (Ohlendorf et al. 1988). Lowered hatching success and a reduced fledgling rate in common terns (*Sterna hirundo*) were associated with mercury concentrations between 1.0 and 3.6 mg/kg (wet weight; Connors et al. 1975), whereas herring gulls (*Larus argentatus*) were apparently not affected when eggs contained 2 to 16 mg/kg mercury (wet weight; Vermeer et al. 1973). Mallard (*Anas platyrhynchos*) reproductive success was reduced when eggs contained about 0.85 mg/kg mercury (fresh weight; Heinz 1979).

Some species of birds, such as the brown pelican (*Pelecanus occidentalis*) are especially sensitive to adverse effects of DDE on reproductive success (Elliott and Noble 1993). Terns appear to be intermediate among avian species in their sensitivity to DDE. More than 25 percent of eggs laid by Caspian terns breeding in San Diego Bay in 1981 failed to hatch, or died during piping (Ohlendorf et al. 1985). Although DDE residues in eggs averaged 9.3 mg/kg (wet weight) and were inversely correlated with eggshell thickness, residues were not significantly related to hatching success. In the Great Lakes, common tern populations declined during the 1970s, and there is some evidence that organochlorine contaminants were one factor that reduced reproductive success (Weseloh et al. 1989). By 1981, DDE concentrations in eggs had declined substantially and seemed no longer to be an important factor in the population dynamics of common terns on the Great Lakes. Geometric mean DDE concentrations in some colonies were 10 to 13 mg/kg (wet weight) during 1972, and they had declined to 2.5 mg/kg or less in those colonies by 1981.

The USFWS also analyzed samples of addled least tern eggs salvaged from colonies in San Francisco Bay and San Diego Bay during the mid-1980s (D.L. Roster, USFWS, personal communication 1994). The samples from the 1980s included 43 eggs analyzed for mercury and selenium (12 samples from San Francisco Bay, 17 samples from San Diego Bay), and 42 eggs analyzed for organochlorines (13 samples from San Francisco Bay, 18 samples from San Diego Bay; as at the NWR, eggs were sometimes composited because they were small and some samples were analyzed for both inorganics and organics, but not all). Although results of those analyses have not been compared statistically to the results for NWR eggs, some general comparisons can be made.

None of the least tern eggs from San Francisco Bay had less than 1 mg/kg mercury, and concentrations ranged up to 3.2 mg/kg (D.L. Roster, USFWS, personal communication 1994). In contrast, more of the eggs (almost half) from San Diego Bay had less than 1 mg/kg mercury, and mercury concentrations ranged up to 2.3 mg/kg. DDE concentrations in eggs from San Francisco Bay were 0.54 to 1.83 mg/kg (fresh wet weight); those from San Diego Bay also were less than 2.0 mg/kg. Without more detailed verification of sample handling and the basis for reporting contaminant concentrations in the various samples, the results for least tern eggs indicate generally that mercury and DDE concentrations at the NWR are not unusual. Mercury concentrations seem comparable to those found in eggs at San Diego Bay (and lower than those found in San Francisco Bay), and DDE concentrations are more similar to those found in San Francisco Bay (although apparently higher than those found at San Diego Bay), as shown in Table 5-6.

During 1991, the USFWS collected eight clapper rail eggs at the NWR and analyzed five of them for inorganic and three for organic contaminants (S.L. Goodbred, USFWS, personal communication 1994). Cadmium and lead were below the detection limit (0.5mg/kg dry weight) and other metals occurred at relatively low concentrations. Although background levels for metals in clapper rail eggs are not well known, geometric means were 1.16 mg chromium/kg, 2.5 mg copper/kg, 0.07 mg mercury/kg, and 49.6 mg zinc/kg. The low range of values for mercury (<0.1 to 0.12 mg/kg) indicates that concentrations in the NWR food chain are low. By comparison, mercury concentrations in 51 California clapper rail eggs salvaged from San Francisco Bay in 1986 and 1992 averaged about 0.6 mg/kg fresh wet weight (or about 1.8 mg/kg dry weight (S.E. Schwarzbach, USFWS, personal communication 1994). Similarly, the concentrations of DDE in rail eggs from the NWR were below 1.0 mg/kg (0.31, 0.34, and 0.89 mg/kg wet weight, not corrected for moisture loss, so fresh wet-weight concentrations would be still lower).

Other organochlorines (such as trans-nonachlor and PCBs), as well as PAHs (such as pyrene and phenanthrene), occurred only at concentrations lower than 0.5 mg/kg and 0.1 mg/kg, respectively.

Contaminants such as the mercury and DDE found in least tern eggs reflect exposure outside of the NWR as well as within the NWR. However, DDE in fish at the NWR does represent a concern for least terns feeding upon them because reproductive success could be adversely affected.

It is important to note that tern egg samples collected from the NWR represent a biased sample of the population because all these eggs were collected when they had failed to hatch.

Other Studies

Several IRP studies that have been or currently are being conducted at or near the NWR provide useful information for interpreting the NWR study results. Chemicals of Potential Concern (COPCs) from the soil, surface water, and groundwater sampling locations of Operable Units (OUs) 4, 5, 6, and 7 that border on the NWR sample locations stations are listed in Attachment 1 of Appendix D. Those OU 4 sites of concern, because of their proximity to the NWR, include Site 5, along the Kitts Highway, and Sites 6, 23, 35, and 38, because of their proximity to POLB Ponds 1, 2, 3, and 4. Slightly elevated levels of copper, lead, mercury, nickel, and zinc were detected in soils from Site 5, which is near NWR sampling locations A-1, B-1 and C-1, as shown in Figure 5-2. Copper and lead were elevated in NWR sediment samples at sample locations A-1 and B-1. Copper was elevated in invertebrates collected in the NWR study at sample location C-1 and lead was elevated in invertebrates collected at sample locations B-1 and C-1. The proximity of

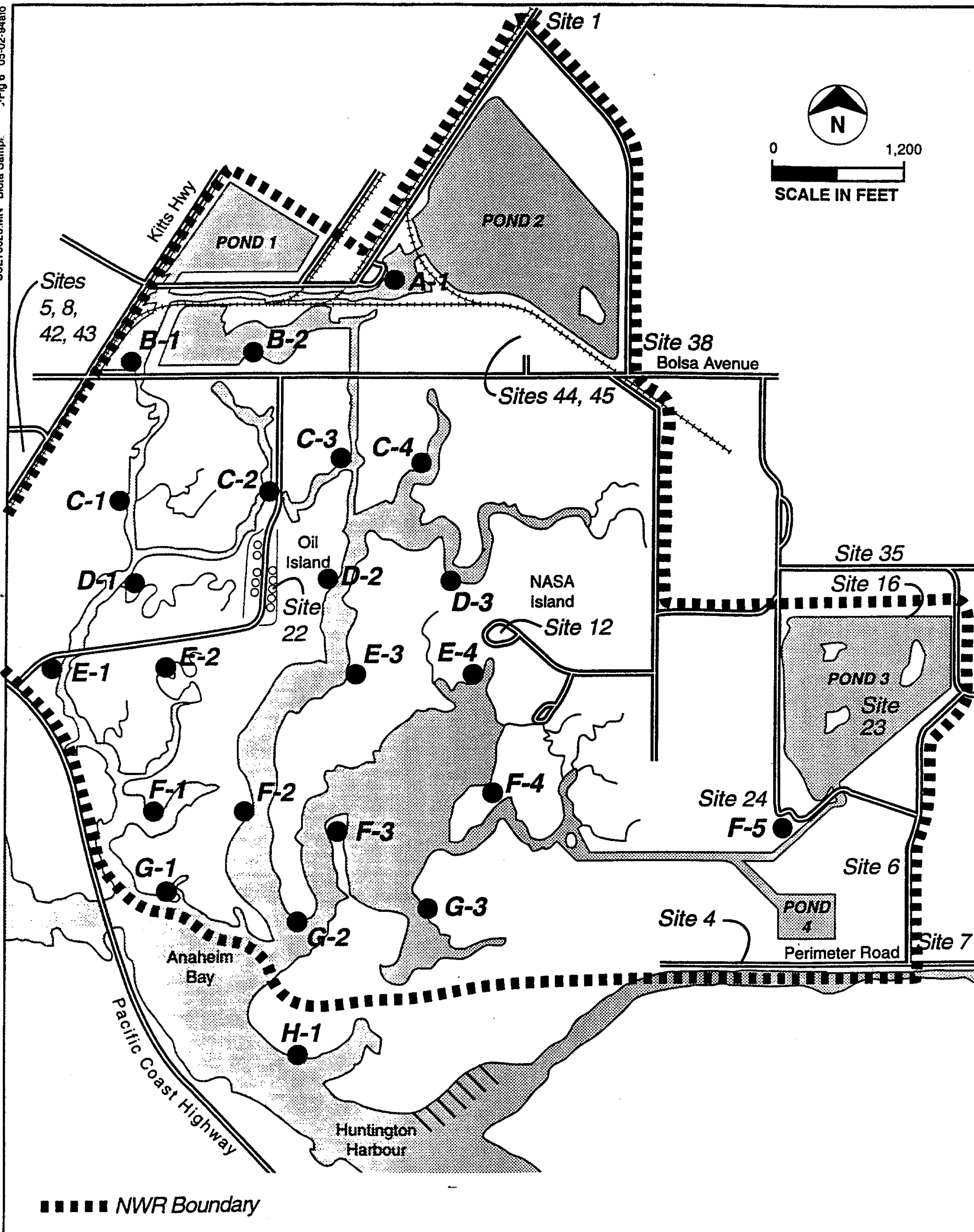

FIGURE 5-2
LOCATIONS OF INSTALLATION RESTORATION PROGRAM SITES AT SEAL BEACH NWR

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Table 5-6
Comparison of Mercury and DDE Concentrations in Least Tern Eggs Salvaged From Nesting Colonies at Seal Beach NWR, San Diego Bay, and San Francisco Bay

Location	Years	Mercury		DDE	
		N		N	
Seal Beach NWR	1991 & 1993	9/9[a]	0.82[b] (1.26)	11/11	3.65 (6.98)
San Diego Bay	mid-1980s	?/17[f]	<1-2.3[d]	?/18[f]	<2[e]
San Francisco Bay	mid-1980s	12/12	1-3.2[d]	13/13	0.54-1.8[e]

a Number of samples with measurable concentrations/number of samples analyzed.
b Reported as mg/kg dry weight (value in parentheses is maximum detected).
c Reported as mg/kg wet weight (not corrected to fresh wet weight (value in parentheses is maximum detected.
d Range, as mg/kg dry weight.
e mg/kg fresh wet weight (corrected for moisture loss during incubation).
f Number of samples with measurable concentrations/number of samples analyzed not available.

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Site 5 to the west arm of the NWR, and the potential for sediment transport in the west arm may result in distribution and deposition of these chemicals in the NWR. Analytical results from Sites 6, 23, 35, and 38 did not reveal COCs with regard to exposure in NWR locations (SWDIV 1993).

All of the OU 5 sites are located in proximity to the NWR and could potentially contribute contaminants to the tidal saltmarsh or POLB ponds. Sites 8, 42, and 43 border the west edge of the tidal saltmarsh near NWR sample locations B-1 and C-1 and drain directly to the NWR. Sites 44 and 45 are located near POLB Pond 2. Site 16 is located adjacent to POLB Pond 3. Site 12 is NASA Island, where the least tern colony is located near NWR sample locations D-3 and E-4 (SWDIV 1994a). Site 12 is unique in providing potential direct contact between the least terns and onsite contaminants. The contaminants of concern from the SI study for Sites 8, 42, and 43 (SWDIV 1994b) include cadmium, lead, and 1,2-DCAA in groundwater. Sites 44 and 45 had elevated levels of nickel and several organic compounds (benzene, naphthalene, phenanthrene, 2-methylnaphthalene) in groundwater. NASA Island (Site 12) contained elevated levels of antimony and thallium in groundwater. Groundwater from Site 16, adjacent to POLB Pond 3, also contained elevated levels of antimony.

A number of sites were evaluated for OUs 6 and 7, but only Sites 4 (the oiled perimeter road) and 24 (quench water disposal area) are in proximity to the NWR and of concern for elevated contaminants. Both sites were included in the Site Investigation (SI) report (SWDIV 1990). The perimeter road was found to be free of detectable levels of PCBs and hazardous levels of heavy metals, but recent samples indicated elevated lead concentrations from the road area near POLB Pond 4 and F-5 (B. Wong, unpub. data 1994). No elevated levels of contaminants were found in the soil, surface water, or horned snail samples from Site 24.

Previous investigations at the NWS have revealed various soil and groundwater contaminants, as well as bioaccumulation in invertebrates of the tidal saltmarsh. Site 1, near the POLB Pond 2, had elevated levels of metals in the soil, with chromium of greatest concern for groundwater contamination (SWDIV 1990). Site 7 contains landfill waste and is located near POLB Ponds 3 and 4 and NWR sample location F-5. Elevated contaminants in soil and groundwater include chromium, copper, and possibly mercury and zinc. Site 22, Oil Island, is entirely surrounded by the tidal saltmarsh and is in proximity to NWR sample locations C-2, C-3, D-2, E-2, and G-3. Chromium and mercury in horned snails collected at sites around Oil Island were elevated in comparison to State Mussel Watch data for other species of molluscs (SWDIV 1990).

The POLB pond monitoring program provides a regular census of the diversity and abundance of fish and invertebrates within the four POLB ponds. Results from those studies generally confirm the NWR Study fish sampling results. The list of species collected (Table 3-1) includes fewer species than the POLB collections, primarily as a result more diverse sampling techniques applied to POLB ponds (designed to capture all size classes of fish). Our species and relative abundance estimates generally concur with the POLB monitoring data (MEC 1992).

The NOAA has conducted an extensive study of temporal and spatial contaminant trends in fish and macroinvertebrates from the Southern California Bight from Point Conception to San Diego (Mearns et al. 1991). Their results are generally not applicable to the NWR Study. The focus of the NOAA contaminants characterization was on edible tissue and livers rather than whole body tissues analyzed in the NWR Study. In addition, species included in the study from the NWR area were different than those collected in the NWR Study. Furthermore, fish in the Bight show elevated levels of DDT and its metabolites as a result of past waste disposal practices in the Los Angeles area.

The CSMW monitoring results for transplanted California mussels provide a useful comparison to the NWR Study as a characterization of the spatial pattern of contamination and for an assessment of the elevation of chemical concentrations over background. In addition, CSMW results provide partial data toward identifying temporal contaminant trends. However, the CSMW and NWR study species are different and, therefore, CSMW tissue chemistry results are not directly comparable to the NWR study data.

The CSMW does not show any clear temporal trends in contamination. Different stations and analytes show opposite trends for both inorganic and organic contaminants, as indicated in Table 5-7. The only exception to this is that the highest values of several of the inorganic and organic contaminants occurred in the earlier samples (1985 and 1986). Some spatial patterns are apparent. The Bolsa Chica Channel station (CSMW 713), just outside of the NWR, shows higher concentrations of cadmium, lead, and possibly mercury in recent years (Table 5-7). The lack of sampling of some stations in recent years precludes an effective evaluation of Anaheim Bay spatial patterns.

Water and sediments of Huntington Harbour and Anaheim Bay, as well as in upstream drainage areas, have been examined for contaminant chemistry and toxicity in two Regional Water Quality Control Board (RWQCB) Santa Ana Region studies. The sampling locations in one study (Olson and Martinez 1993; Bailey et al. 1993) do not include NWR sites, but the results are generally indicative of upstream sediment and water quality and may indicate sources of NWR contamination. A separate, ongoing RWQCB study (Reid, 1994) will include information on sediment contamination and bioaccumulation in the NWR, although results are not yet available. Copper and lead were listed as inorganic COCs for surface water runoff into the Anaheim Bay/Huntington Harbour system in the Regional Board studies, with copper of greatest concern (Olson and Martinez 1993). Organochlorine compounds exceeding water quality criteria included heptachlor, dieldrin, and DDT. Sediment contaminant results showed generally lower concentrations in the marsh and Anaheim Bay entrance locations than upstream in Huntington Harbour and the Huntington Harbour-Warner Avenue bridge. Sediment contaminants that were elevated in upstream locations included cadmium, copper, mercury, zinc, DDE, DDT, cis-nonachlor, and trans-nonachlor (H. Smythe, RWQCB, unpub. data), indicating sources for these chemicals outside the NWR in the Huntington Harbour drainage. Anaheim Bay watershed samples exhibited toxicity at all sampling locations tested in the RWQCB study. Toxicity identification results

Table 5-7
California State Mussel Watch Data
for the Anaheim Bay Area

Year		1985		1986			1990-91			1991-92		
CSMW Station		710.2	713	708	710.2	713	708	708.5	713	708	708.5	713
Closest NWR Station	CSMW EDL85[a]	H1	Bolsa Chica Channel	G2	H1	Bolsa Chica Channel	G2	G2	Bolsa Chica Channel	G2	G2	Bolsa Chica Channel
INORGANICS (mg/kg, dry weight)												
Cadmium	10.83	3.88	4.74	4.92	5.70	4.95	5.70	9.30	16.00	5.40	5.70	11.00
Chromium	3.93	1.71	2.56	1.62	2.11	2.76	15.00	3.20	2.80	1.40	1.50	1.80
Copper	21.85	8.7	12.7	7.4	10.7	11.9	13.0	13.0	11.0	11.0	12.0	14.0
Lead	11.01	14.11	15.86	5.27	12.07	12.35	4.80	1.70	6.60	3.50	3.00	6.50
Mercury	0.44	0.109	0.175	0.253	0.326	0.470	0.130	0.240	0.290	0.080	0.140	0.230
Zinc	336.3	206	256	198	279	255	280	330	230	200	210	280
ORGANICS (ug/kg, wet weight)												
4,4'-DDD	NA	13.7	14.4	20.0	8.3	19.0	4.1	3.6	3.1	5.9	2.8	5.6
4,4'-DDE	NA	81.9	49.5	79.2	52.8	52.5	20.4	33.2	11.6	79.0	65.0	53.0
4,4'-DDT	85.5	3.9	6.6	4.9	1.8	6.6	ND	0.9	0.9	1.6	1.6	1.7
Total DDT	1,483.0	115.2	80.5	138.6	76.0	100.5	31.6	48.5	18.0	103.5	80.8	68.6
cis-Nonachlor	NA	ND	3.30	ND	ND	ND	0.90	1.60	1.10	1.50	1.60	1.10
trans-Nonachlor	NA	6.94	5.94	7.60	2.90	6.50	1.50	2.10	1.10	2.80	1.90	1.80
PCB 1254	1,420	74.8	49.5	91.8	36.8	76.5	10.8	17.4	9.3	51.0	40.0	44.0
Total PCBs	1,420	74.8	49.5	91.8	36.8	76.5	10.8	17.4	9.3	51.0	40.0	52.0

CSMW = California State Mussel Watch
NWR = Seal Beach National Wildlife Refuge
ND = Not Detected
NA = Not Available
[a]Phillips, 1988; Elevated data levels (85th percentile) for inorganic chemicals as mg/kg dry weight and for organics as μg/kg dry weight.

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indicated that non-volatile organics were most likely responsible for the acute toxicity observed in the watershed runoff samples (Bailey et al. 1993).

The evaluation of sediment erosion and deposition in the NWR tidal saltmarsh system did not clearly reflect the observed patterns of contamination in the tidal saltmarsh. Although some areas of relatively high biotic contamination, such as the four POLB ponds, are areas of sediment deposition, the sites of highest bioaccumulation are evenly spread among NWR sites characterized as either deposition-prone, of high erosion potential, or as falling somewhere between those extremes. This lack of complete coincidence of patterns may be partially attributable to possible ongoing changes in sediment distribution discussed earlier.

In contrast, the description of the physical characteristics of the Anaheim Bay watershed, in conjunction with a knowledge of areas of deposition and erosion within the NWR, may reveal offsite sources of contamination to the NWR. State and local water, sediment, and contaminant bioaccumulation studies (discussed above) have indicated generally higher levels of contamination in the Bolsa Chica Channel and Huntington Harbour than near the mouth of Anaheim Bay. The watershed study revealed that most of the surrounding urban, upland areas, totalling more than 23,000 acres, drain through the Bolsa Chica Channel to the lower end of Huntington Harbour near the eastern edge of the Anaheim Bay saltmarsh. Various metals and organic chemicals have been characterized as elevated in water and sediment in these upstream drainages (Olson and Martinez 1993; Bailey et al. 1993; H. Smythe, RWQCB, pers. comm. 1994). Based on the current understanding of hydrodynamics of the Anaheim Bay system, including the NWR, it is likely that they may contribute contaminants to the NWR from outside sources. As discussed above, the patterns of bioaccumulation in the tidal saltmarsh identified in the NWR Study do not support or refute this hypothesis. It is, therefore, not possible to use these studies to partition the degree of contamination in the NWR food-chain between NWS sources and those originating outside NWS Seal Beach.

In summary, through the Navy's SI or RI/Feasibility Study (FS) or various state contaminant assessment programs, several chemicals have been found at elevated concentrations in proximity to or within the NWR in media that could potentially result in exposure to biota. The COCs, as revealed by the chemical analyses of other IRP studies that are consistent with and confirmed by the NWR Study results, including media and potential exposure route are:

- o Cadmium: groundwater, potential bioaccumulation from food chain
- o Chromium: soil, groundwater, potential bioaccumulation from food chain
- o Copper: surface water, soil
- o Lead: surface water, soil, potential bioaccumulation from food chain

- Mercury: soil

- Nickel: groundwater, soil, potential bioaccumulation from food chain

- Zinc: soil, possible toxicity in sediments

- DDT: surface water, potential bioaccumulation from food chain

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6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

6.1.1 Spatial Pattern of Contamination

The patterns of elevated levels of contaminants in sediment at the NWR sometimes are reproduced in potential effect level concentrations found in invertebrate and fish tissue in several areas of the Anaheim Bay saltmarsh system. However, the spatial patterns of contamination for inorganic and organic chemicals are somewhat different and reflect different sources. In addition, some chemicals showed no consistent pattern of distribution in the biota that would relate to source areas at the NWS Seal Beach.

- o Inorganics of concern (primarily cadmium, chromium, copper, lead, and zinc) were clustered as two main areas of soil, sediment, contamination and bioaccumulation (in the area of NWR sample location B-1 and on the opposite side of the NWR in the POLB Pond 3 and NWR sample locations E-4, F-5, G-2, and G-3 area). Nickel showed no discernible pattern of distribution.

- o The organic contaminant DDE showed elevated bioaccumulation values in the area of POLB Ponds 1 and 2 and NWR sample locations A-1 and B-1. PCBs were generally undetected and did not demonstrate a discernible spatial pattern. Other organic compounds were not detected in high enough frequency in the biota samples to provide information on spatial patterns.

o Phase I NWR Study results indicate no link to RI Sites.

6.1.2 Potential for Adverse Effects to NWR Endangered Species

Table 6-1 lists chemicals of concern due to their presence in the tissues of dietary species of birds at the NWR, particularly the clapper rails and least terns. It also provides an explanation for the overall level of concern related to each chemical and the rationale for assigning that level (See also Table 5-2 and text in Section 5.0).

Table 6-1
Chemicals of Concern
NWS Seal Beach, NWR Study Report

Chemical	Reason for Concern	Level of Concern	Rationale for Level of Concern
Cadmium	Maximum detected concentration exceeds assessment levels for invertebrates. Potentially toxic levels.	Low	Assessment value is very conservative, and ratio of highest sample location mean for invertebrates to assessment value is less than 1.0.
Chromium	Maximum detected concentration exceeds assessment levels for invertebrates and fish. Toxic levels.	Low	Ratio of maximum detected concentration to assessment value is less than 2.0, and ratios of invertebrate and fish means to assessment values are less than 1.0.
Copper	Maximum detected concentration exceeds assessment levels for invertebrates. Potentially toxic levels.	Low	Maximum detected concentration was in ghost shrimp, which seem to have high copper levels naturally and are not primary foods of clapper rails. Ratios of mean concentrations for invertebrates at all sample locations are less than 1.0.

Table 6-1
Chemicals of Concern
NWS Seal Beach, NWR Study Report

Chemical	Reason for Concern	Level of Concern	Rationale for Level of Concern
Lead	Maximum detected concentration exceeds assessment levels for invertebrates. Potentially toxic levels. Bioaccumulates.	Low-Moderate	Maximum detected concentration in invertebrates exceeds 10 times assessment value, but ratios of means for all sample locations in all fish species are less than 1.0.
Nickel	Maximum detected elevated levels in invertebrates and fish. Potentially toxic levels.	Low	Although nickel concentrations were elevated in comparison to some assessment values, the maximum detected concentrations and means were less than the final assessment values.
Zinc	Maximum detected concentrations exceeds assessment levels for invertebrates. Potentially toxic levels.	Low	Maximum detected concentration slightly exceeds final assessment value, but all invertebrate sample location means and fish species means are well below final assessment value.
DDE	Maximum detected concentration equals or exceeds assessment levels for invertebrates and fish. Bioaccumulates.	Moderate-High	Maximum detected concentrations in invertebrates equals final assessment value, but ratios for all sample location means are less than 1.0. However, the ratios of maximum detected concentration for fish to final assessment value exceeds 30 and the highest fish species mean is 10 times the assessment value.
PCBs	Maximum detected concentration exceeds assessment levels for invertebrates and fish. Bioaccumulates.	Low	Ratios of maximum invertebrate sample location mean and maximum fish species mean to final assessment value are less than 0.5.

Inorganic and organic contaminants are not expected to cause lethal effects on clapper rails or least terns at the concentrations found in food chain components at the NWR. Similarly, the contaminants found in least tern eggs do not indicate likely lethal effects in nesting birds. The most likely sublethal effects that could be expected (if clapper rails and least terns are similar to other species that have been tested) include eggshell thinning, with reduced reproductive success in least terns as a result of DDE found in fish.

Other potential sublethal or indirect effects include the following, although probabilities are low:

- Cadmium - Retarded growth, anemia, testicular damage.

- Chromium - Altered growth patterns and reduced survival of young.

- Copper - Feather loss, reduced food intake leading to weight loss or reduced weight gain and egg production.

- Lead - Highly variable effects, but possibly loss of appetite, lethargy, weakness, lesions of various organs. However, ingestion of food containing biologically incorporated lead, although contributing to the lead burden of carnivorous birds, is unlikely in itself to cause clinical lead poisoning (Eisler 1988b).

- Nickel - Reduced growth rate (but less effect when iron and zinc are elevated).

- Zinc - Possible effects on benthic invertebrates.

- PCBs - Possible effects in sensitive species of fish when whole-body concentrations are 0.4 mg/kg fresh weight or higher (concentrations in diet are not expected to affect birds directly.) Maximum PCB concentrations in deepbody anchovy were 0.74 mg/kg; in topsmelt they were 0.46 mg/kg. Geometric means were 0.18 and 0.066 mg/kg fresh weight.

6.2 Recommendations

This NWR Study Report completes the Navy's responsibility to assess the impacts of operations at NWS Seal Beach on the biota of the NWR.

The observed levels of invertebrate and fish contamination in the NWR do not warrant a concern for immediate remediation. However, because of the potential for sediment transport in the NWR resulting from construction of the POLB ponds, the following actions are recommended:

o Food-chain organisms should be monitored for evidence of further bioaccumulation of toxic chemicals that might increase the risk of exposure to endangered species or other species in the NWR. Horned snails, saltmarsh snails, and deepbody anchovy (if available) should be sampled from the two general areas of sample locations A-1, B-1, and POLB Pond 1 and sample locations F-5, G-3, and POLB Ponds 3 and 4 annually and analyzed for metals and organochlorine compounds as an assessment of exposure of endangered species to contaminated food organisms. These areas show consistently elevated levels of contamination and food organisms may experience further bioaccumulation as older, contaminated areas continue to erode and contribute new chemicals to the ecosystem. It is also recommended that POLB Ponds 2 and 4 be included in this sampling. While samples collected from these ponds did not consistently show the highest levels of chemicals, expected patterns of sediment deposition could increase chemical concentrations in sediments and biota in these ponds. Heavy use of these ponds for foraging by the least tern, and future use for nesting by the clapper rail makes information on the status of chemicals in sediments and biota important. Bioaccumulation monitoring may be incorporated into the RI/FS decisions on site remediation and/or mitigation monitoring.

- If not already part of the USFWS least tern monitoring effort, eggshells from the least tern colony at NASA Island and clapper rail eggshells should be collected and measured to assess the possibility of thinning as a result of DDE concentrations in fish or invertebrates.

- Sediment samples should be collected in identified areas of contamination that are subject to erosion or deposition. These include POLB Ponds 1, 2, 3, and 4 where no sediment was collected in Phase I NWR Study, and sample locations A-1 and B-1, which seem to be a potential source of contaminants as a result of sediment transport. Investigation of potential contaminants in soil and water in the drainage that enters the NWR near sample location B-1 would be an important part of these additional studies. These data will be collected under the Navy's Storm Water Monitoring Program. The basis for this recommendation is the need to provide information on the potential changes in distribution of contaminants in the sediments and resulting effects on the biota in the NWR. Of particular concern are erosion and deposition involving the POLB ponds and nearby locations that are critical feeding areas for the least tern and that will become nesting habitat for the clapper rail when they are colonized by saltmarsh vegetation. These anticipated changes in potentially contaminated sediment were found through our sediment transport modeling to be primarily attributable to the changes in the hydraulics in the NWR resulting from construction and operation of the POLB ponds.

Initially, annual monitoring is anticipated, but the timing and interval for monitoring could be adjusted based on results of each successive monitoring events. As discussed above, a new dynamic equilibrium for sediment transport would occur after installation of the POLB ponds. The point in this transitional process at which the biota and sediment sampling for the NWR Wildlife Refuge Study occurred is unknown. Samples taken 2 years following the 1993 sampling event may or may not show comparable contaminant levels and spatial distribution. If results from the first monitoring event show differences from those from the 1992/93 sample analyses, additional monitoring events (at an interval to be determined based on results) could be warranted. If, however, there are no substantial differences, no additional monitoring may be advised. The frequency and nature of this monitoring could be developed in conjunction with pertinent agencies, but should include replicate samples from each location for each sampling event.

To track the potential occurrence of sublethal effects of identified contaminants on the clapper rail and the least tern, continued coordination with the USFWS is advised in order to have access to analyses on addled eggs that they may collect, as well as any population information they may have for these species.

Responsibility for the monitoring effort should be determined based on the conditions included in the MOV, which provided for the use of the NWR for POLB mitigation ponds. The MOV was signed by POLB, USFFFWS, Navy, CDFGF, and NMFS.

7.0 REFERENCES

Anderson, J.A., Bay, S.M. and Thompson, B.E. 1988. Southern California Coastal Water Research Project. Characteristics of and Effects of Contaminated Sediments from Southern California.

Bailey, H.C., C. DiGiorgio, and D.E. Hinton. 1993. Anaheim Bay Watershed Toxicity Study. Final Report for Testing Events 10-17 November 1992, and 16-23 February 1993. Prepared for California Regional Quality Control Board, Santa Ana Region. Department of Medicine, School of Veterinary Medicine, University of California, Davis.

Bhogal, V.K., and S.L. Costa. "Modeling flood tidal deposits in tidal inlets." *Oceans 89*. 1989.

Bhogal, V.K. "A sediment dynamics model for flood and tidal delta evolution." *Marine Technology Society Journal.* 23(1):37-43. March 1989.

Cain, B.W., L. Sileo, J.C. Franson, and J. Moore. 1983. Effects of Dietary Cadmium on Mallard Ducklings. *Environmental Research* 32:286-297.

Costa, S.L., and J.D. Isaacs. The Modification of Sand Transport in Tidal Inlets. Proc. Symposium on Coastal Sediments and Structures, ASCE. Charleston, South Carolina. November 1977.

Eisler, R. 1985a. *Cadmium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service; Biological Report 85(1.2). Washington, DC.

———. 1985b. *Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service; Biological Report 85(1.5). Washington, DC.

———. 1986a. *Chromium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service; Biological Report 85(1.6). Washington, DC.

———. 1986b. *Polychlorinated Biphenyl Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service; Biological Report 85(1.7). Washington, DC.

———. 1987a. *Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service; Biological Report 85(1.10). Washington, DC.

———. 1987b. *Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service; Biological Report 85(1.11). Washington, DC.

———. 1988a. *Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service; Biological Report 85(1.12). Washington, DC.

———. 1988b. *Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service; Biological Report 85(1.14). Washington, DC.

———. 1989. *Molybdenum Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service; Biological Report 85(1.19). Washington, DC.

———. 1990a. *Boron Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service; Biological Report 85(1.20). Washington, DC.

———. 1990b. *Chlordane Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service; Biological Report 85(1.21). Washington, DC.

———. 1993. *Zinc Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service; Biological Report 10. Washington, DC.

Elliott, J.E., and D.G. Noble. 1993. Chlorinated Hydrocarbon Contaminants in Marine Birds of the Temperate North Pacific. *The Status, Ecology, and Conservation of Marine Birds of the North Pacific*. K. Vermeer, K. T. Briggs, K. H. Morgan, and D. Siegel-Causey, eds. Ottowa, Canada, Can. Wild. Serv. Spec. Publ. Pp. 241-253.

Furness, R. W., and P. S. Rainbow. 1990. *Heavy Metals in the Marine Environment*. CRC Press, Boca Raton, Florida.

Goodbred, S.L. 1994. Personal Communication with Steve Goodbred, USFWS, to Harry M. Ohlendorf, CH2M HILL. 22 March.

Graf, W.H., Hydraulics of Sediment Transport. McGraw-Hill, Inc. 1971.

Heinz, G.H. 1979. Methylmercury: Reproductive and Behavioral Effects on Three Generations of Mallard Ducks. *Journal of Wildlife Management* 43:394-401.

Hothem, R.L., and H.M. Ohlendorf. 1989. Contaminants in Foods of Aquatic Birds at Kesterson Reservoir, California, 1985. *Arch. Environ. Contam. Toxicol.* 18:773-786.

Jenkins, D.W. 1980. Biological Monitoring of Toxic Trace Metals - Volume 2. Toxic Trace Metals in Plants and Animals of the World. Part II. Environmental Monitoring Systems Laboratory. Office of Research and Development, U.S. Environmental Protection Agency, Las Vegas, Nevada, 89114.

Katz, A. and I.R. Kaplan. 1981. *Heavy Metals Behavior in Coastal Sediments of Southern California: A Critical Review and Synthesis*. Marine Chemistry 10:261-299.

Koutitas, C.G. 1988. *Mathematical Models in Coastal Engineering*. Pentech Press Limited. 1988

Lindsay, W.L., 1974. Chemical Equilibrium in Soils. John Wiley and Sons, N.Y.

Long, E.R., and L.G. Morgan. 1990. *The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program*. NOAA Technical Memorandum NOS OMA 52.

Mearns, A.J., M. Matta, G. Shigenaka, D. MacDonald, M. Buchman, H. Harris, J. Golas, and G. Lauenstein. 1991. *Contaminant Trends in the Southern California Bight:*

Inventory and Assessment. NOAA Technical Memorandum NOS ORCA 62, Seattle, Washington. October.

Microbics Corp. 1991. Microtox® Manual, Solid-Phase Test Protocol. Carlsbad, California.

MEC. 1992. Anaheim Bay Biomitigation Monitoring Project. Eighth Quarterly Report, February-April 1992. Submitted to the Port of Long Beach, Port Planning Department, Long Beach, California. Submitted by MEC Analytical System, Inc. Carlsbad, California. April 15, 1992.

NAS. See National Academy of Sciences.

National Academy of Sciences-National Academy of Engineering. 1973. Water Quality Criteria 1972 (Blue Book). EPA Ecological Research Series. EPA-R3-73-033. U.S. Environmental Protection Agency, Washington, D.C.

National Academy of Sciences. 1980. Mineral Tolerance of Domestic Animals. Washington, DC.

National Ocean Service. 1993. Tide Tables 1993, High and Low Water Predictions, West Coast of North and South America, Including the Hawaiian Islands. U.S. Department of Commerce.

Nauen, C.E. 1983. Compilation of Legal Limits for Hazardous Substances in Fish and Fishery Products, Circular No. 764. FIRI/C764, Food and Agricultural Organization of the United Nations.

Ohlendorf, H.M., R.W. Risebrough, and K. Vermeer. 1978. *Exposure of Marine Birds to Environmental Pollutants*. U.S. Fish and Wildlife Service, Washington, D.C. Wildlife Research Report 9.

Ohlendorf, H.M., T.W. Custer, R.W. Lowe, M. Rigney, and E. Cromartie. 1988. Organochlorines and Mercury in Eggs of Coastal Terns and Herons in California, USA. *Colonial Waterbirds* 11:85-94.

Ohlendorf, H.M., R.L. Hothem, and D. Welsh. 1989. Nest Success, Cause-Specific Nest Failure, and Hatchability of Aquatic Birds at Selenium-Contaminated Kesterson Reservoir and a Reference Site. *Condor* 91: 787-796.

Ohlendorf, H.M. 1993. Marine Birds and Trace Elements in the Temperature North Pacific. *The Status, Ecology, and Conservation of Marine Birds of the North Pacific.*

Ohlendorf, H.M., F.C. Schaffner, T.W. Custer, and C.J. Stafford. 1985. Reproduction and Organochlorine Contaminants in Terns at San Diego Bay. *Colonial Waterbirds* 8:42-53.

Olson, T.M., and A. Martinez. 1993. Anaheim Bay Basin Update Plan Study, Draft Final Report. Prepared for California Regional Water Quality Control Board, Santa Ana Region. Department of Civil Engineering, University of California, Irvine. August.

Pardue, J.H., R.D. Dehune, and W. H. Patrick, Jr. 1992. Metal to Aluminum Correlation in Louisiana Coastal Wetlands; Identification of Elevated Metal Concentrations. J. Environ. Qual. 21:539-545.

Pearson, R.G., M.R., Litterick, and N. V. Jones. 1973. An Air-Lift for Quantitative Sampling of the Benthos. *Freshwater Biology* 3:309-315.

Phillips, D.J.H. 1990. Arsenic in Aquatic Organisms: A Review Emphasizing Chemical Speciation. Aquatic Toxicol. 16:151-186.

Phillips, P.T. 1988. California State Mussel Watch Ten Year Data Summary 1977-1987. State Water Resources Control Board, Sacramento, Division of Water Quality. Water Quality Monitoring Report No. 87-3. May.

Puls, R. 1988. Mineral Levels in Animal Health, Diagnostic Data. Sherpa International, Clearbrook, B.C.

Rasmussen, D. 1992. Toxic Substances Monitoring Program, 1990 Data Report. State Water Resources Control Board, Division of Water Quality, Sacramento. Water Quality Monitoring Report 92-1WQ. May.

Reid, M. 1994. Personal communication from Mike Reid, State Water Resources Control Board, to Marjorie Castleberry, CH2M HILL. February 4.

Roster, D.L. 1994. Personal Communication with Doug Roster, USFWS, to Harry M. Ohlendorf, CH2M HILL. 28 March.

Scheuhammer, A.M. 1987. The Chronic Toxicity of Aluminum, Cadmium, Mercury, and Lead in Birds: A Review. *Environ. Pollut.* 46:263-295.

Schmitt, C.J., J.L. Zajicek, and P. H. Peterman. 1990. National Contaminant Biomonitoring Program: Residues of Organochlorine Chemicals in U.S. Freshwater Fish, 1976-1984. *Arch. Environ. Contam. Toxicol.* 19:748-781.

Schmitt, C.J., and W.G. Brumbaugh. 1990. National Contaminant Biomonitoring Program: Concentrations of Arsenic, Cadmium, Copper, Lead, Mercury, Selenium, and Zinc in U.S. Freshwater Fish, 1976-1984. *Arch. Environ. Contam. Toxicol.* 19:731-747.

Schropp, S., F. Lewis, H. Windom, J. Ryan, F. Calder, and L. Burney. 1990. Interpretation of Metal Concentrations in Estuarine Sediments of Fluoride Using Aluminum as a Reference Element,. *Estuaries* 13:227-235.

Schuler, C.A. 1987. Impacts of Agricultural Drainwater and Contaminants on Wetlands at Kesterson Reservoir, California. Master of Science Thesis, Oregon State University, Corvallis. June.

Schwarzbach, S.E. 1994. Personal communication from Steve Schwarzbach, USFWS to Harry M. Ohlendorf, CH2M HILL. February 3.

Smythe, H. 1994. Personal Communication with Hope Smythe, Santa Ana RWQCB, to Marjorie Castleberry, CH2M HILL. 10 January.

Southwest Division, Naval Facilities Engineering Command (SWDIV). 1990. *Naval Weapons Station Seal Beach, California. Installation Restoration Program, Final Site Inspection Report. Volume I - Technical Report.* October.

————. 1992. *Naval Weapons Station Seal Beach, California. Installation Restoration Program, Final Wildlife Refuge Study Work Plan.* 23 July.

————. 1993. *Naval Weapons Station Seal Beach California.* Installation Restoration Program, Draft Operable Unit-4 Site Inspection Report, Volume I. 28 October.

————. 1994a. *Naval Weapons Station Seal Beach, Installation Restoration Program, Draft Final Remedial Investigation Report.* 31 December.

————. 1994b. *Naval Weapons Station Seal Beach, Installation Restoration Program, Preliminary Draft Operable Unit 5 Site Inspection Report*, 13 January.

Stanley, T.R., Jr., J.W. Spann, G.J. Smith, and R. Rosscoe. 1994. Main and Interactive Effects in Arsenic and Selenium on Mallard. Reproduction and Duckling Growth and Survival. Archives of Environmental Contamination and Toxicology 26:444-451

State of Florida. 1993. Development of an Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Florida Department of Environmental Regulation (January).

State of California. 1993. Status of the Bay Protection and Toxic Cleanup Program. Staff Report. Bay Protection and Toxic Cleanup Program, State Water Resources Control Board, Sacramento, California. November.

Stauble, D.K., et al. *Sediment Dynamics of a Sand Bypass Inlet.* Reprinted from "Coastal Sediments '87." WW Div./ASCE. New Orleans, Louisiana. May 1987.

————. Inlet Flood Tidal Delta Development Through Sediment Transport Processes, pp 319-347 in: D.G. Aubrey and L. Weishar (eds.), Hydrodynamics and Sediment Dynamics of Tidal Inlets: Lecture Notes on Coastal and Estuarine Studies. Volume 29. Springer-Verlag. 1988.

Stickel, L.F. 1973. Pesticide Residues in Birds and Mammals. In *Environmental Pollution by Pesticides*, C.A. Edwards, ed. Plenum Press, New York, NY. Pp. 254-312.

U.S.D.I. 1993. Personal Communication (letter) from RaJean Strube Fossen, Bureau of Reclamation, to Harry Ohlendorf, CH2M HILL. 12 July.

U.S. Fish and Wildlife Service. 1989. Unpublished Contaminant Data, Ecological Services Field Office, Laguna Niguel, California.

U.S. Fish and Wildlife Service and the U.S. Navy. 1990. *Final Environmental Endangered Impact Statement. Species Management and Protection Plan.* Naval Weapons Station Seal Beach, Seal Beach National Wildlife Refuge. August.

U.S. Food and Drug Administration. 1994. *Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed.* USFDA, Washington, D.C.

U.S. Navy. 1985. Initial Assessment Study of Naval Weapons Station, Seal Beach, California. Naval Energy and Environmental Support Activity (NEESA) 13-062, Port Hueneme, California.

———. 1989. Remedial Investigation Verification Step for Naval Weapons Station Seal Beach, California. Naval Energy and Environmental Support Activity (NEESA) 21-0038, Port Hueneme, California.

Vermeer, K., F.A.J. Armstrong, and D.R.M. Hatch. 1973. Mercury in Aquatic Birds at Clay Lake, Western Ontario. *Journal of Wildlife Management* 37:58-61.

Vermeer, K., K.T. Briggs, K.H. Morgan, and D. Siegel-Causey, eds. Ottawa, Canada: Can. Wild. Serv. Spec. Publ. Pp. 232-240.

Weseloh, D., T.W. Custer, and B.M. Braune. 1989. "Organochlorine Contaminants in Eggs of Common Terns from the Canadian Great Lakes, 1981." *Environmental Pollution* 59:141-160.

White D.H., M.T. Finley, and J.F. Ferrell. 1978. "Histopathologic Effects of Dietary Cadmium on Kidneys and Testes of Mallard Ducks." *Journal of Toxicology and Environmental Health* 4:551-558.

White, D.H., and M.T. Finley. 1978. Effects of Dietary Cadmium in Mallard Ducks. Trace Substances in Environmental Health XII. A symposium. D. D. Hemphill, ed. University of Missouri, Columbia. Pp. 220-223.

White, D.H., and M.P. Dieter. 1978. Effects of Dietary Vanadium in Mallard Ducks. *Journal of Toxicology and Environmental Health* 4:43-50.

Zembal, R., and J.M. Fancher. 1988. Foraging Behavior and Foods of the Light-footed Clapper Rail. *Condor* 90:959-962.

Appendix A

NWS SEAL BEACH WATERSHED AND LAND USE CHARACTERIZATION

Appendix A

NWS Seal Beach Watershed and Land Use Characterization

Prepared by Beth Chambers, Don Kingery, and Kathy Freas

INTRODUCTION

The National Wildlife Refuge (NWR) Study at Naval Weapons Station (NWS) Seal Beach is being conducted to assess the impacts of NWS Seal Beach operations on the NWR. The 911-acre NWR, located within the boundaries of the NWS, contains the remaining natural tidal saltmarsh of the once larger Anaheim Bay system. The NWR is occupied by several special-status species, including the California Brown Pelican, the American peregrine Falcon, the Belding's Savannah Sparrow, the California Least Tern, and the Light-footed Clapper Rail.

Several potential hazardous waste disposal sites and contaminated areas on the NWS were identified during an Initial Assessment Study conducted in 1985. The purpose of the NWR Study is to evaluate the impacts of NWS Seal Beach operations by evaluating hazardous waste contaminants in the sediments and biota within the NWR and assessing the background levels of these contaminants. Background levels are defined as the levels of contaminants that would exist in the NWR in the absence of NWS Seal Beach.

A phased approach has been defined for the study. The purpose of the first phase is to assess contaminant levels in the sediments and biota in the NWR, evaluate the physical processes involved in movement and distribution of contaminants throughout the NWR, identify potential sources of contamination through assessment of the watershed land use and runoff patterns, and identify criteria for choosing a comparable site to be used in the determination of background contamination levels at the NWR. This technical memorandum documents the results of the watershed land use and runoff characterization task for Phase I of the Seal Beach NWR Study, and identifies criteria for choice of a comparable site.

Objectives

The primary objectives of this task are to describe the physical characteristics of the watershed, identify potential sources of contamination to the NWR, and develop criteria for selection of a comparable site that may be used to directly characterize background contaminant levels.

Approach

Contamination is considered to come from sources either associated with the operations at NWS Seal Beach, or those separate from NWS Seal Beach operations. The sources separate from operations at NWS Seal Beach offer a measure of the background levels of contaminants in the NWR. Selection and monitoring of a comparable site with similar land use and watershed characteristics (minus the Naval Weapons Station) would allow evaluation of contaminant levels that are representative of the background levels at the NWR. This task supports the evaluation of background levels in the NWR by characterizing the land use and runoff patterns of the surrounding watershed.

The emphasis of this task is the compilation of available data required to describe the land use and runoff patterns for the watershed. Analysis of the data is consistent with the Phase I objectives of the project of evaluating the characteristics of the watershed in order to identify potential outside contamination sources and characterize the watershed. The watershed characteristics are quantified to the extent discussed below. Additional analysis will be performed during Phase II, as required, and will focus on the areas of importance determined during Phase I.

The task is divided into three sequential subtasks: (1) Collection of available data on the hydrology and land use of the surrounding watershed, (2) Incorporating the collected data onto map overlays, and (3) Analysis and documentation of the data.

Data Collection

Data describing the hydrology and land use of the watershed surrounding the NWR were collected from a variety of federal, state, and local agencies, as well as site visits and other independent sources. U.S. Geological Survey (USGS) topographic maps were used to develop the base map for the area and help determine the boundaries of the watershed.

Sources for hydrologic and runoff data included the Orange County Environmental Management Agency (OCEMA), precipitation records from the California Department of Water Resources (CDWR), Soil Conservation Service (SCS) soils maps, the U.S. Environmental Protection Agency's (EPA's) STORET System database, and data from various state and local agencies on drainage in the area. Land use data were obtained from the CDWR, Orange County, local cities, and through recent aerial photographs.

A catalogue of pertinent data collected during this phase is included as Attachment 1 to this Appendix.

Mapping

USGS 7-1/2 minute quadrangle maps were used to develop a base map of the area. Delineation of watershed basin and subbasin boundaries and soils characteristics were produced on mylar overlays to the base map. This base map, combined with the overlays, provides the working map for the Phase I analysis and any follow-on Phase II analysis of contributions of watershed runoff to background contamination.

Analysis

Characterization of the watershed for the purposes of evaluating background contaminant levels in the NWR requires understanding the hydrology of the area, characterizing land use in the watershed, and evaluating waterborne pollutants in the watershed runoff. As discussed above, an objective of characterizing the watershed is to develop criteria for selection of a comparable site for determining background levels. The analysis focuses on describing the watershed hydrology, topography, and land use patterns to a level required for understanding potential sources of contaminants and for selection of a comparable site.

Evaluation of a candidate comparable site would consider similarities with the NWR watershed with respect to precipitation, land use patterns, soil types, and topographical features. Runoff from the watersheds is a function of the above watershed characteristics. A site with similar precipitation, topography, soil types, and land use patterns would be expected to have similar runoff patterns. To the extent that information is available, runoff patterns are presented based on analysis in existing reports to indicate relative quantities of runoff from each subbasin. No attempt has been made to rigorously quantify the runoff from the watershed. Precipitation for the coastal and inland portions of the watershed is characterized based on data from two representative stations. Land use patterns, soil types, and topographical features are described in general terms for the watershed as a whole.

In addition to characterizing the watershed, potential sources of contamination are evaluated based on existing data. Existing water quality data were obtained using EPA's STORET system, which is a database of sampling sites and their associated water quality data.

Watershed Characterization

Figure 1 shows the watershed boundaries and major drainage pathways for surface water runoff into the NWR. The watershed is divided into eight subbasins: NWS Seal Beach, and seven areas surrounding NWS Seal Beach. The areas to the north and west of the NWS that are not included within the watershed boundaries drain into the Pacific Ocean via the San Gabriel River, thus would have a negligible effect on the contaminants entering the NWR.

The watershed is extensively developed with runoff flowing through a series of flood control channels (Figure 1). Potential pathways into the NWR for contaminants in surface water runoff are direct runoff from NWS Seal Beach and via the NWR's connection with Anaheim Bay. Pathways for surface water contaminants from the surrounding watershed (not including the NWS) are through Anaheim Bay via discharges into Anaheim Bay, Huntington

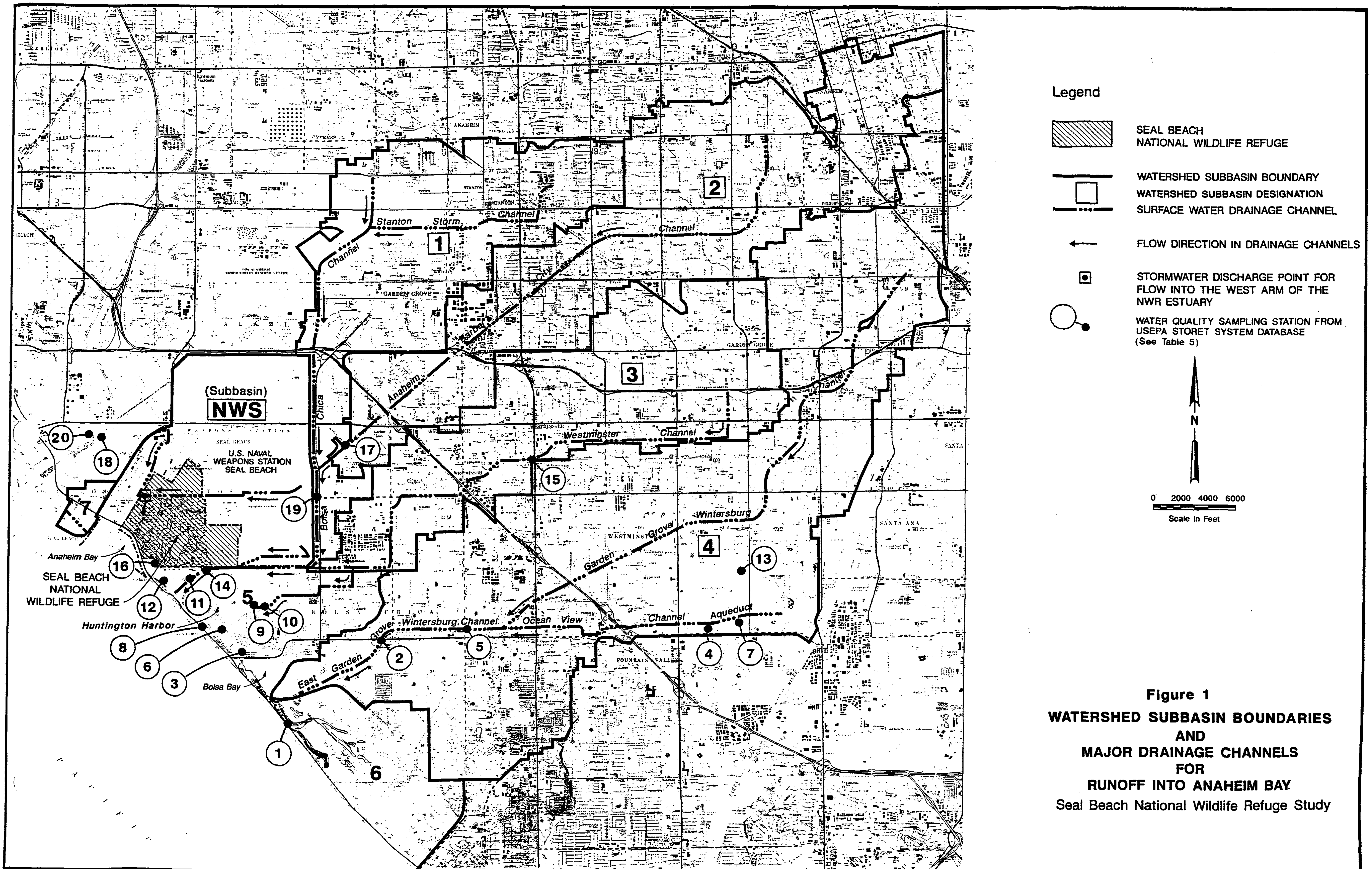

Figure 1
WATERSHED SUBBASIN BOUNDARIES AND MAJOR DRAINAGE CHANNELS FOR RUNOFF INTO ANAHEIM BAY
Seal Beach National Wildlife Refuge Study

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Harbour, and Bolsa Bay. Figure 2 shows surface water discharge points from the drainage channels. A summary of the watershed subbasins shown in Figure 1 is presented as Table 1.

The total watershed area, including NWS Seal Beach, is approximately 48,000 to 50,000 acres. Estimates of the surface area of the estuary (including Anaheim Bay, the NWR, Huntington Harbour, and Bolsa Bay) were made using a planimeter to measure areas on a USGS topographic map. The measured area was approximately 1,400 to 1,900 acres for a watershed to estuary ratio of approximately 25:1 to 36:1.

Land Use and Topography

The topography of the watershed can be characterized as a flat, coastal plain with average slopes for the subbasins 1 through 5 and 7 of less than 0.3 percent. The western portion of subbasin 6 is predominantly marshland at or near sea level with hills with elevations reaching 125 feet on the eastern end. The average slope from the eastern edge of the watershed to the edge of the marsh is about 2.3 percent with an overall average slope across the length of the watershed of about 0.8 percent.

Land use is a major factor affecting runoff and background contamination coming from the watershed. Land use maps showing major land use classifications for the watershed subbasins were obtained from the Department of Water Resources. The analysis was simplified by combining classifications into the following groups: residential, commercial, industrial, agricultural, and other. The group "other" includes parks, cemeteries, ornamental landscaping, and unpaved open space.

The Anaheim Bay watershed is highly developed. Development is primarily residential, with supporting park, school, and commercial developments interspersed throughout. Land use in subbasin 6 is approximately half industrial, consisting of oil fields with about three quarters of the remaining land in native and non-native vegetation and the rest residential.

Soils

Figure 3 indicates the soil associations for the overall watershed. A soil association is a landscape with a distinctive proportional pattern of soils consisting of one or more major soils and at least one minor soil. The hydrologic soil groups associated with each of the soil associations are indicated in the legend for the map and are presented in Table 2. Hydrologic soil groups are used to estimate runoff from precipitation.

The U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS, undated) describes the four hydrologic soil groups as:

Table 1
Watershed Subbasin Summary

Subbasin	Primary Drainage Paths	Discharge Point	Size[1] (Acres)
NWS	On-base ditches and channels	Estuary West Arm, Anaheim Bay, Bolsa Chica Channel	5,003
1	Stanton Storm Channel Bolsa Chica Channel	Huntington Harbour (west)	5,610 to 5,860
2	Anaheim-Barber City Channel	Huntington Harbour (west)	9,590 to 10,370
3	Westminster Channel	Huntington Harbour (west)	6,960 to 7,350
4	East Garden Grove - Wintersburg Channel Ocean View Channel	Bolsa Bay	17,946
5	Sunset Channel	Huntington Harbour (east)	970
6	(non point runoff)	Bolsa Bay	2,230
7	Seal Beach Storm Drain and Pump Station	Anaheim Bay	250

1 Watershed area for subbasin 6 based on planimeter measurement of estimated basin boundaries, all other areas based on existing hydrology reports.

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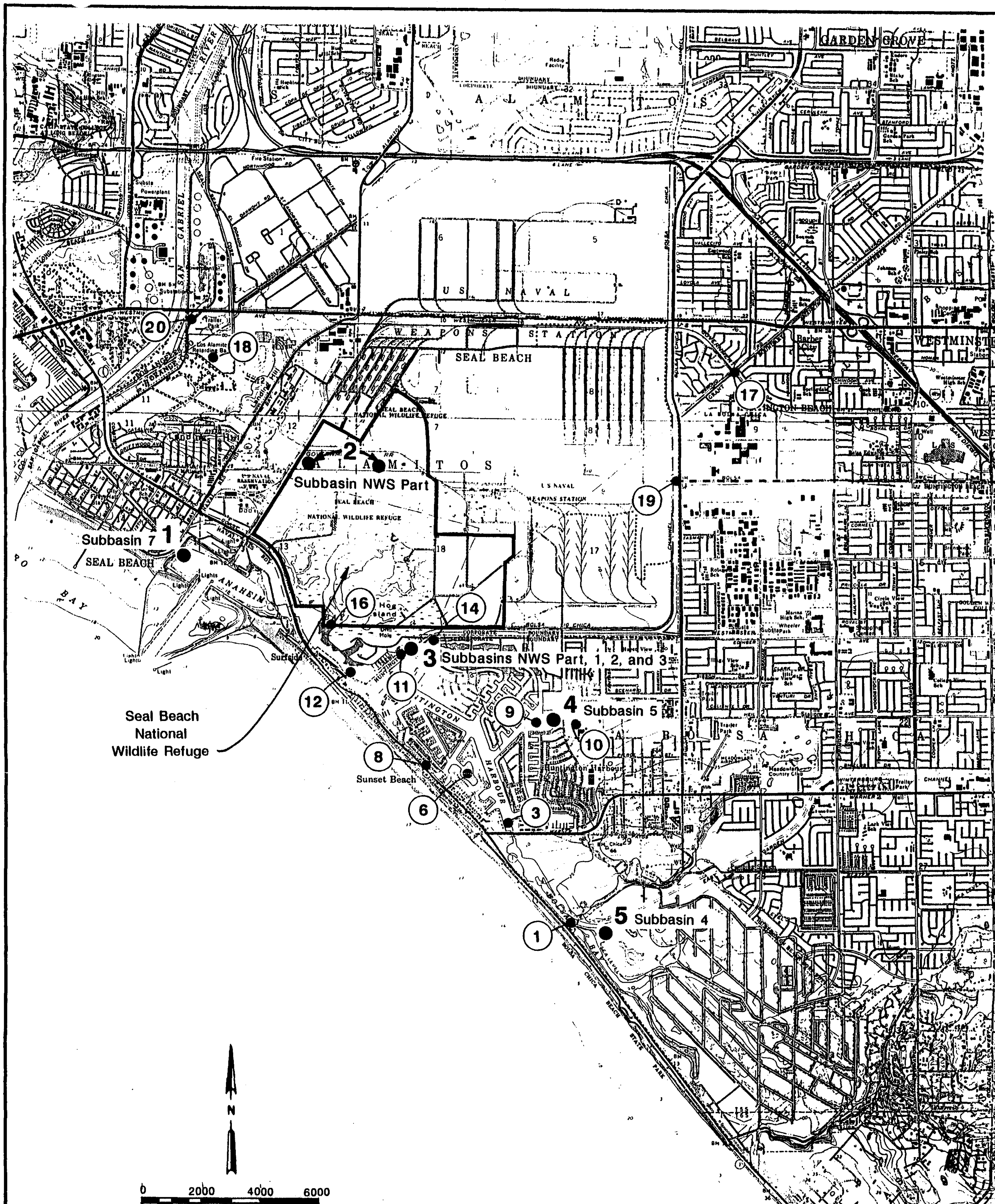

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● Discharge Point

○• Water Quality Sampling Station From USEPA Storet System Database (See Table 5)

Figure 2
DISCHARGE POINTS FOR RUNOFF FROM ANAHEIM BAY WATERSHED
Seal Beach National Wildlife Refuge Study

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Table 2
Hydrologic Soil Groups for Anaheim Bay Watershed

Soil Association	Hydrologic Soil Group
(1) Chino-Omni	C, D
(2) Hueneme-Bolsa	B, C
(3) Metz-San Emigdio	A, B
(4) Sorrento-Mocho	B
(5) Myford	D
(6) Alo-Bosanko	D

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These soils consist chiefly of deep, well-drained to excessively-drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These soils consist chiefly of moderately-deep or deep, moderately-well drained or well-drained soils that have moderately fine texture to moderately course texture. These soils have a moderate rate of water transmission.

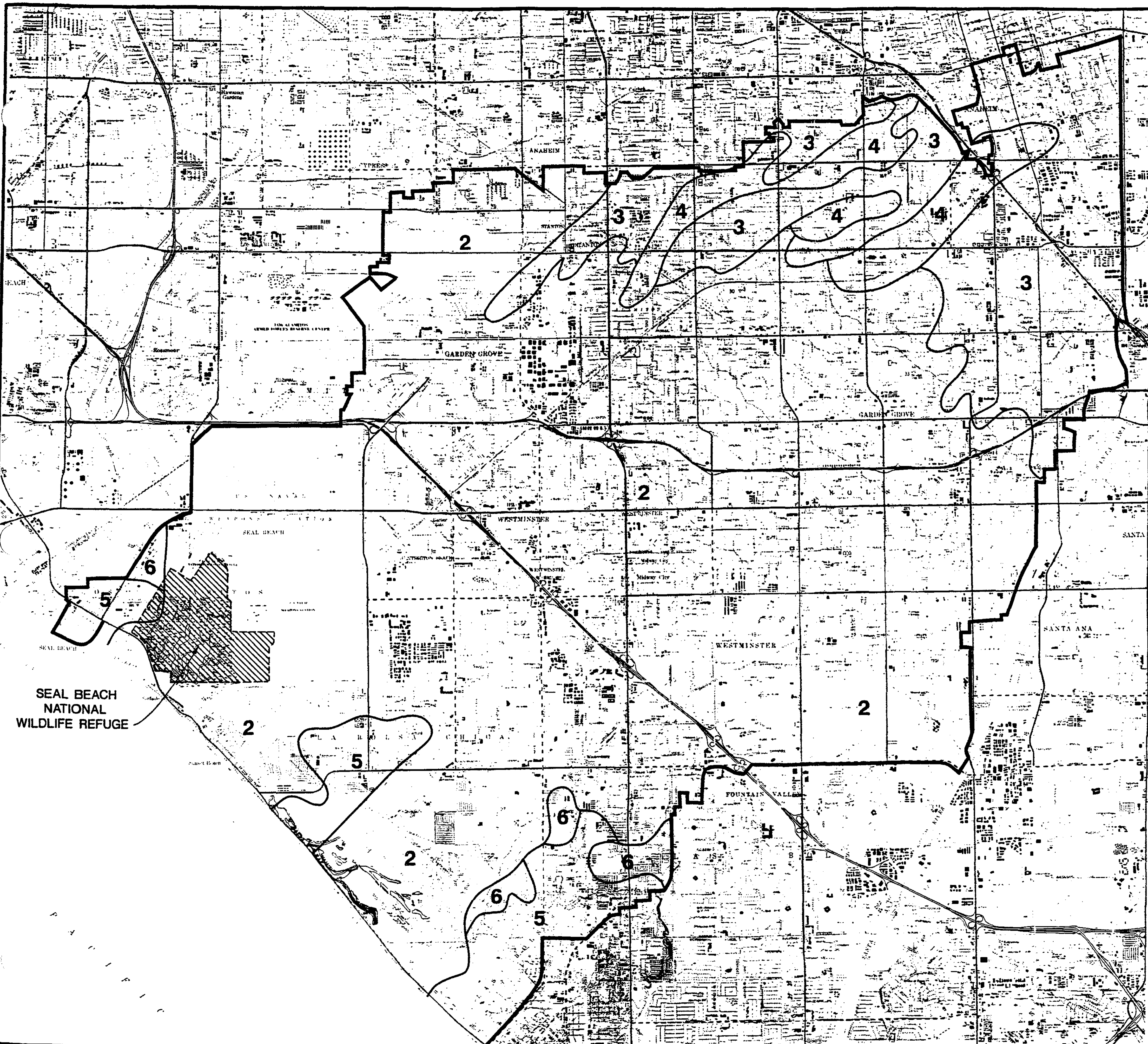
Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils with moderately-fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Soil patterns classified as Hueneme-Bolsa associations (#2 on the figure) make up approximately 70 percent of the total watershed area. These soils have moderate to slow rates of water transmission. Pockets of Metz-San Emigdio (#3) and Sorrento-Mocho (#4) association soils account for 20 to 25 percent on the northeast portion of the watershed. These soils have moderate to high rates of water transmission resulting in relatively low runoff potential. The remaining 5 to 10 percent of the watershed consists of pockets of Myford (#5) and Alo-Bosanko (#6) association soils along the coastline. These soils have very slow rates of water transmission with high runoff potential.

Watershed Hydrology

Precipitation patterns were evaluated using data from the Santa Ana Fire Station (Index No. 7888), representing precipitation patterns for the inland portions of the watershed, and the Long Beach Fire Station (Index No. 5085), representing coastal patterns. Rainfall for this area is highly variable with annual totals ranging from a low of 3.37 inches in 1961 to a high of 26.26 inches in 1978. Monthly totals show comparable variability. The Long Beach



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WATERSHED BOUNDARY

Hydrologic Soil Group	Soil Associations*
	SOMEWHAT EXCESSIVELY DRAINED TO POORLY DRAINED, NEARLY LEVEL TO MODERATELY SLOPING SOILS ON ALLUVIAL FANS AND FLOOD PLAINS AND IN BASINS OF THE COASTAL PLAINS
	1 Chino-Omni association: Nearly level, somewhat poorly drained and poorly drained, calcareous silt loams to clays on alluvial fans and flood plains and in basins (Not Applicable to this area)
B and C	**2** Hueneme-Bolsa association: Nearly level, poorly drained and somewhat poorly drained, calcareous fine sandy loams, silt loams, and silty clay loams on alluvial fans and flood plains
A and B	**3** Metz-San Emigdio association: Nearly level, somewhat excessively drained and well drained, calcareous loamy sands and fine sandy loams on alluvial fans and flood plains
B	**4** Sorrento-Mocho association: Nearly level to moderately sloping, well drained sandy loams, loams, or clay loams on alluvial fans and flood plains
	MODERATELY WELL DRAINED, NEARLY LEVEL TO MODERATELY STEEP SOILS OF THE COASTAL TERRACES
D	**5** Myford association: Nearly level to moderately steep, moderately well drained sandy loams that have strongly developed subsoil; on terraces
	SOMEWHAT EXCESSIVELY DRAINED AND WELL DRAINED, STRONGLY SLOPING TO VERY STEEP SOILS OF THE COASTAL FOOTHILLS
D	**6** Alo-Bosanko association: Strongly sloping to steep, well drained clays on coastal foothills

N

0 2000 4000 6000

Scale In Feet

*Textures in names of associations refer to the surface layer of the major soils.

Figure 3

GENERAL SOIL MAP FOR THE ANAHEIM BAY WATERSHED

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Fire Station records indicate a mean annual precipitation of 11.8 inches for a record period from 1957 through 1980. Mean monthly rainfall values are highest from November through April, with a peak in February of 2.83 inches. Little or no precipitation typically occurs during the remaining months. Data for the Santa Ana Fire Station show patterns similar to those for Long Beach, but with a slightly higher average annual rainfall of 12.4 inches for the same period of record.

Runoff into Anaheim Bay from the watershed subbasins is low during most months, with periods of higher flow during the winter and early spring corresponding to periods of higher precipitation. A summary of data from stream gauge stations presented in the 1990-1991 Hydrologic Data Report for Orange County (OCEMA, 1991) is shown in Table 3. Data in Table 3 represent runoff for the majority of the watershed. Not included in Table 3 are the small subbasins for the residential areas around Huntington Harbour and in Seal Beach (subbasins 5 and 7) or the basin containing the Bolsa Chica reserve. The records in Table 3 are for a single year of data and provide a comparison between the various subbasins, but do not necessarily represent flow for a typical year. Data summaries from other years indicate that mean daily and total flows can be twice these values during wet years.

Table 4 summarizes extreme precipitation event data obtained from various hydrology reports. The data represent peak flows for 25- and 100-year events. These data are typically used for stormwater management purposes, such as sizing drainage channels.

These data were not available for subbasin 6 (the Bolsa Chica Reserve) where drainage improvements have not been made.

Contaminant Source Evaluation

Potential sources of contamination in the NWR can be evaluated using existing water and sediment quality data taken throughout the watershed. These data were identified using the EPA's STORET System database of sampling sites and their associated quality information. Table 5 presents a summary of sampling sites that were identified, along with the years of the first and last samples taken.

Summaries of data for the relevant stations are included with this Appendix as Attachment 2. Each summary lists the parameters measured, number of detects, and statistical information (maximum, minimum, mean, and variance) for the parameter concentrations. These data include measurements for a wide range of organic and inorganic constituents.

The significance of these data is evaluated in Appendix D, and considered in conjunction with results of the hydrodynamic and sediments transport modeling, in order to assess the potential for contamination in the NWR from the surrounding watershed.

Table 3
1990-91 Streamflow Data for Anaheim Bay Watershed Drainage

Stream Gauge Location	Basin No.	Peak Daily Flow (1)	Mom. Peak Flow (1)	Normal Flow Range (1)	Mean Daily Flow (1991) (1)	Total Volume (2)
Bolsa Chica Channel @ Westminster (3)	1	1030 (0.176)	4040 (0.69)	0.2-1	11.58 (0.002)	8208 (1.40)
Anaheim-Barber City Channel before Bolsa Chica Channel	2	331 (0.032)	1763 (0.17)	0.3-5	4.77 (0.0005)	3224 (0.311)
Westminster Channel @ Beach	3	148 (0.020)	475 (.065)	0	7.8 (0.0011)	1118 (0.152)
E. Garden Grove-Wintersburg Channel	4	343 (0.019)	1280 (0.07)	1-4	6.33 (0.0004)	4501 (0.251)
	Totals:	1,852 (0.045)	7,558 (.182)	1.5-10	30 (0.0007)	17,051 (0.411)

(1) *Units are in cfs.* Numbers in parentheses are relative to the watershed area with units in cfs/acre.
(2) Units are in acre-ft. Numbers in parentheses are relative to the watershed area with units in acre-ft/acre.
(3) High flows for the Bolsa Chica Channel are inconsistent with flows from previous years when compared to data from the channels for subbasins 2, 3, and 4. Possible error in streamflow data.

Table 4
Estimated Watershed Runoff from
Orange County Flood Control District Hydrology Reports

Subbasin	Basin Size (acres)	Total Runoff (cfs)		Relative Runoff (cfs/acre)	
		25-year	100-year	25-year	100-year
1+2+3	23580		12000		0.509
2	9590		7450		0.777
3	7350	4520	6020	0.615	0.819
4	17946	9290	12480	0.518	0.695
5	970	740		0.763	
7	250	150	185	0.600	0.740

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Table 5
Summary of Sampling Locations for Water Quality Data Retrieved from the Storet System Database

Agency	Location[1]	Dates
Orange County Environmental Management Agency (OCEMA)	(1) Old launch ramp, Bolsa Bay	1973-1991
	(2) East Garden Grove-Wintersburg Channel at Warner Ave	1973-1974
	(3) Huntington Harbour, 100 yards North of Warner Ave	1976-1991
	(4) Mile Square Park Rain Sta.	1974-1979
	(5) East Garden Grove-Wintersburg Channel at Golden West Street Bridge	1973-1992
	(6) Huntington Harbour, circular bay north of Sharkfin and Marina Bay intersection	1979-1990
	(7) Mile Square Park, south side of Phase I Lake	1976-1990
	(8) Huntington Harbour at Broadway Street bridge	1979-1990
	(9) Huntington Harbour, Christiana Bay	1976-1991
	(10) C07 at Heil Ave bridge	1973-1983
	(11) Huntington Harbour at entrance of Bolsa Chica Channel	1976-1991
	(12) Huntington Harbour at Harbour entrance	1976-1990
	(13) Mile Square Park, south side of Phase II Lake	1976-1990
	(14) Bolsa Chica Channel at Edinger Ave	1973
	(15) Westminster Channel at Hazard/Beach Blvd	1976-1992
	(16) Huntington Harbour, Sunset Bay at Navy Bouys[2]	1976-1991
	(17) C03 at Navy Railroad bridge	1979-1992
	(18) Los Alamitos Retarding Basin at pump station inlet	1973-1981
	(19) Bolsa Chica Channel at Bolsa Ave extension bridge	1973-1992
Dept of Public Works	(20) Alamitos Barrier Project	1974-1986

1 Numbers correspond to reference numbers on maps of the Anaheim Bay watershed (Figures 1 and 2).
2 Sample station at the entrance to the middle and eastern arms of the NWR.

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Conclusions and Recommendations

The above characterization of the Anaheim Bay watershed is adequate for assessing potential sources of contaminants to the NWR and for selecting a comparable site for the purpose of evaluating background levels of contaminants from sources other than NWS Seal Beach. To the extent possible, the selected site should have similar relative watershed size, topography, soil types, land use, and precipitation patterns to those described above.

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REFERENCES

Orange County Environmental Management Agency. *Hydrologic Data Report, 1990-1991 Season, Volume XXVII, Environmental Resources Division, Santa Ana, CA*

Soil Conservation Service and Forest Service, Soil Survey of Orange County and Western Part of Riverside County, California, United States Department of Agriculture

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Attachment 1

ANAHEIM BAY WATERSHED DATA SOURCES

Attachment 1

ANAHEIM BAY WATERSHED DATA SOURCES

DATA COLLECTED

Land use maps

City of Fountain Valley

Land Use Plan, Buena Park General Plan, Adopted by Resolution 7315 on March 15, 1982, Amended March 22, 1991 by Resolution 9268. From OCEMA/Flood Program Division.

Department of Water Resources (DWR) land use maps corresponding to USGS topographic maps for Seal Beach, Newport Beach, Anaheim, and Los Alamitos.

Hydrology Reports

(From Orange County Environmental Management Agency (OCEMA) Public Works)

Los Alamitos Channel Facility No. C01 and Los Alamitos Retarding Basin Facility No. C01B01. Prepared by Orange County Flood Control District. Includes description of drainage area, channels, 25- and 100-year discharge curves, Drainage Area Map, and Land Use and Soil Group Map.

Hydrology Report No. C02-4. Bolsa Chica Channel, Facility No. C02. San Diego Freeway to Cerritos Avenue.

Hydrology Report No. C00P02-2. Seal Beach Storm Drain, Facility No. C00P02.

Hydrology Report No. C00PS1-2. Seal Beach Pump Station, Facility No. C00PS1.

Hydrology Report No. C02-2. Bolsa Chica Channel, Facility No. C02, From Edinger Avenue to Huntley Avenue.

Hydrology Report No. C03-4. Anaheim-Barber City Channel, Facility No. C03, entire drainage system.

Hydrology Study, Westminster Channel, Facility No. C04, entire drainage area.

Hydrology Report for East Garden Grove-Wintersburg Channel (Facility No. C05), Bolsa Chica Bay to Vermont Avenue, Volume I, July 1990.

Hydrology Report No. C06-2, Ocean View Channel, Facility No. C06, entire drainage system, November 1989.

Hydrology Report No. C07-1, Sunset Channel, Facility No. C07, entire drainage system.

Draft EIS/EIR for the Proposed Bolsa Chica Project - Describes drainage and watershed for Bolsa Chica.

Anaheim Bay-Huntington Harbour Drainage Basin Map (EIR referenced in workplan)

Development of Water Facilities in the Santa Ana River Basin, California, 1810-1968. By M.B. Scott, USGS, Open-File Report 77-398, May 1977.

Excepts from the 1990-1991 Hydrologic Data Report, OCEMA - Discharge summaries for 11 stream gaging stations, seasonal streamflow data for Westminster Channel station (No. 207), East Garden Grove-Wintersburg Channel (No. 217), Bolsa Chica Channel at Westminster (No. 225), and Anaheim-Barber City Channel (No. 232).

Stormwater Pollution Prevention Plan, Naval Weapons Station, Seal Beach, CA, October 1992.

Soil Survey of Orange County and Western Part of Riverside County, CA, United States Department of Agriculture, Soil Conservation Service and Forest Service STORET system data

Attachment 2

STORET SYSTEM SUMMARIES FOR SEDIMENT AND WATER QUALITY DATA FOR THE ANAHEIM BAY WATERSHED

**** STORET SUMMARY SECTION ****

FOLLOWING IS A RETRIEVAL OF DATA FROM THE ENVIRONMENTAL PROTECTION AGENCY'S STORET SYSTEM, A DATABASE OF SAMPLING SITES AND THEIR ASSOCIATED QUALITY DATA. THE INFORMATION WAS RETRIEVED USING SPECIFIC STORET INSTRUCTION SETS IN COMBINATION TO SELECT ONLY THE DATA REQUESTED FOR THIS RETRIEVAL. BRIEF EXPLANATIONS OF THE INSTRUCTION SETS ARE INCLUDED BELOW. QUESTIONS MAY BE DIRECTED TO THE STORET USER ASSISTANCE SECTION AT (800) 424-9067.

FOLLOWING IS THE FORMAT FOR THE STATION HEADER INFORMATION WHICH APPEARS ON EACH PAGE OF THE RETRIEVAL UNLESS STATION AGGREGATION WAS PERFORMED

	STATION NUMBER(S)
	LATITUDE/LONGITUDE PRECISION CODE
	STATION LOCATION
	STATE/COUNTY CODE STATE NAME COUNTY NAME
	MAJOR BASIN NAME MAJ/MIN/SUB BASIN CODE
	MINOR BASIN NAME
STATION TYPE	AGENCY CODE STORED DATE HYDROLOGIC UNIT
	STATION DEPTH ELEVATION
	ECOREGION
	WATER BODY
	AQUIFERS
	LOCKED DATE
RIVER MILE INDEX	

CONTINUED ON NEXT PAGE(S)

RETRIEVAL PROGRAM

PGM=INVENT
THIS IS AN INVENTORY RETRIEVAL SHOWING SUMMARY STATISTICS FOR ALL PARAMETERS

NO BEGINNING DATE WAS REQUESTED -- STORET ASSUMED THE BEGINNING DATE WAS THAT OF THE OLDEST DATA VALUE FOUND
NO ENDING DATE WAS REQUESTED -- STORET ASSUMED THE ENDING DATE WAS THAT OF THE MOST RECENT DATA VALUE FOUND

STATION SELECTION WAS BY:

LATITUDE/LONGITUDE COORDINATES OR AREA SURROUNDING A SPECIFIED COORDINATE

STATIONS SELECTED WERE RESTRICTED TO:

AGENCIES WHOSE DATA HAS NOT BEEN 'RETIRED'

CONTACTS FOR AGENCY CODES RETRIEVED:

AGENCY	PRIMARY CONTACT NAME	ORGANIZATION	PHONE NUMBER(S)
112WRD	YORK, TOM	US GEOLOGICAL SURVEY	(703)648-5687
21CAOCFC	COLLACUTT, BOB	ORANGE CNTY ENV MNGT AGCY	(714)634-7460
111EPRI	HOELMAN, LOUIS	USEPA HQ	(202)260-7050
21CALAFD	MITCHELL, JOHN K.	DEPT. OF PUBLIC WORKS	(818)458-3537
21CAL-1	LEWIN, SUZANNE	CA WATER RES CONTROL BRD	(916)322-4759
11BIOACC	KRONER, STEVE	U.S. EPA MDSD	(202)260-4761
11NATDC	HOELMAN, LOUIS	USEPA HQ	(202)260-7050
12OWNIRS	WEINER, LAWRENCE J.	EPA/ODW	(202)382-2799
21CAL-4	LEWIN, SUZANNE	CA WATER RES CONTROL BRD	(916)322-4759

DATA RESTRICTIONS:

NOTE
NO DEPTH INDICATOR RESTRICTIONS WERE SPECIFIED - COMPUTATIONS WILL
BE PERFORMED WITHOUT REGARD TO DEPTH INDICATORS

NOTE
NO GRAB/COMPOSITE RESTRICTIONS WERE UTILIZED, SO BOTH GRAB AND COMPOSITE SAMPLE TYPES MAY HAVE
BEEN INCLUDED - COMPUTATIONS WILL BE PERFORMED WITHOUT REGARD TO SAMPLE TYPE

NOTE
NO COMPOSITE SAMPLE RESTRICTIONS WERE SPECIFIED - COMPUTATIONS WILL INCLUDE STATISTICAL FEATURES OF
THE COMPOSITING PROCESS, PRODUCING VALID RESULTS ONLY WHEN SOPHISTICATED COMPOSITES ARE NOT ENCOUNTERED.
SPECIFY COMPOSITE HANDLING KEYWORDS "ANC" AND/OR "DSROC" IF NEEDED

***** END OF SUMMARY SECTION *****

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AT OLD LAUNCH RAMP
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN
BOLSA BAY
21CAOCFC 770817 HQ 18070201001 0007.630 OFF
0000 FEET DEPTH

/TYPA/AMBNT/OCEAN

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER		88	19.96400	13.79600	3.714400	27.0	12.0	77/06/07	91/08/14
00011	WATER	TEMP	FAHN	WATER	$	88	67.93400	44.77100	6.691100	80.6	53.6	77/06/07	91/08/14
00076	TURB	TRBIDMTR	HACH FTU	WATER		91	2.370300	10.95400	3.309700	21.0	.1	77/06/07	91/08/14
00094	CNDUCTVY	FIELD	MICROMHO	WATER		70	41724.00	61285000	7828.500	60000	15000	77/10/11	91/08/14
					L	7	50000.00	.0000000	.0000000	50000	50000	77/08/09	84/08/21
					TOT	77	42477.00	61375000	7834.200	60000	15000	77/08/09	91/08/14
00095	CNDUCTVY	AT 25C	MICROMHO	WATER		87	43494.00	52837000	7268.900	60000	11000	77/06/07	91/08/14
00116	INTNSVE	SURVEY	IDENT	WATER		6	730600.0	.0000000	.0000000	730601	730601	78/01/10	81/02/10
00300	DO		MG/L	WATER		85	6.884300	6.308800	2.511700	14.2	1.6	77/06/07	91/08/14
00301	DO	SATUR	PERCENT	WATER	$	85	74.33100	721.3600	26.85800	156.3	18.4	77/06/07	91/08/14
00310	BOD	5 DAY	MG/L	WATER		5	3.400000	.8000200	.8944400	5.0	3.0	78/04/11	81/05/19
00335	COD	LOWLEVEL	MG/L	WATER		18	298.2800	58265.00	241.3800	806.0	24.0	77/06/07	79/05/09
					K	3	6.000000	75.00000	8.660300	16.0	1.0	77/08/09	78/12/12
					TOT	21	256.5200	60516.00	246.0000	806.0	1.0	77/06/07	79/05/09
00400	PH		SU	WATER		82	8.012600	.2953300	.5434500	11.00	6.62	77/06/07	91/08/14
00403	PH	LAB	SU	WATER		91	7.862700	.1102000	.3319600	8.5	6.8	77/06/07	91/08/14
00530	RESIDUE	TOT NFLT	MG/L	WATER		82	56.87300	8883.100	94.25000	650	2	77/06/07	91/08/14
					K	9	4.500000	2.250000	1.500000	5	.5	80/10/14	90/01/24
					TOT	91	51.69300	8242.100	90.78600	650	.5	77/06/07	91/08/14
00535	RESIDUE	VOL NFLT	MG/L	WATER		76	23.83300	1243.300	35.26000	220	0	77/06/07	90/06/19
					K	14	4.357200	2.670400	1.634100	5	.5	80/10/14	91/08/14
					TOT	90	20.80300	1098.500	33.14400	220	0	77/06/07	91/08/14
00550	OIL-GRSE	TOT-SXLT	MG/L	WATER		13	35.54500	10746.00	103.6600	380.0	.1	78/04/11	85/10/15
					K	2	7.000000	8.000000	2.828400	9.0	5.0	83/11/08	86/10/15
					TOT	15	31.73900	9312.200	96.50000	380.0	.1	78/04/11	86/10/15
00610	NH3+NH4-	N TOTAL	MG/L	WATER		63	.4452400	.3257100	.5707100	4.200	.050	77/11/15	91/08/14
					K	29	.1534500	.0199880	.1413800	.500	.050	77/06/07	89/07/12
					TOT	92	.3532600	.2466400	.4966300	4.200	.050	77/06/07	91/08/14
00612	UN-IONZD	NH3-N	MG/L	WATER	$	79	.0235310	.0028491	.0533770	.385	.0004	77/06/07	91/08/14
00619	UN-IONZD	NH3-NH3	MG/L	WATER	$	79	.0286110	.0042121	.0649000	.469	.0005	77/06/07	91/08/14
00625	TOT KJEL	N	MG/L	WATER		84	1.210600	.8096400	.8998000	4.200	.100	77/06/07	90/06/19
					K	8	.2500000	.0428570	.2070200	.500	.100	78/12/12	91/08/14
					TOT	92	1.127100	.8158300	.9032300	4.200	.100	77/06/07	91/08/14
00650	T PO4	PO4	MG/L	WATER		75	.4121300	.0811730	.2849100	1.99	.01	77/06/07	91/08/14
					K	17	.2805900	.0443680	.2106400	.50	.01	77/11/15	90/05/22
					TOT	92	.3878200	.0764450	.2764900	1.99	.01	77/06/07	91/08/14
00668	PHOS MUD	DRY WGT	MG/KG-P	WATER		1	13.00000			13.0	13.0	82/06/02	82/06/02
00680	T ORG C	C	MG/L	WATER	K	1	3.000000			3.0	3.0	86/10/15	86/10/15
00747	SULFIDE	IN SED.	MG/KG	WATER		1	27.00000			27.00	27.00	82/06/02	82/06/02

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BOLSA BAY
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0000 FEET DEPTH

/TYPA/AMBNT/OCEAN

PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00955 SILICA DISOLVED MG/L	WATER		29	2.634500	8.177300	2.859600	12.9	.2	77/06/07	80/11/12
		K	7	.6871400	.1724900	.4153200	1.0	.01	78/11/07	80/08/12
		TOT	36	2.255800	7.182400	2.680000	12.9	.01	77/06/07	80/11/12
01002 ARSENIC AS,TOT UG/L	WATER		7	17.42900	354.9500	18.84000	45	1	78/11/07	87/05/20
		K	11	9.000000	83.00000	9.110400	33	2	77/07/12	89/01/18
		TOT	18	12.27800	191.9800	13.85600	45	1	77/07/12	89/01/18
01003 ARSENIC SEDMG/KG DRY WGT	WATER		3	2.666700	2.143300	1.464000	4.00	1.10	81/05/19	83/05/10
01027 CADMIUM CD,TOT UG/L	WATER		14	26.50000	668.1200	25.84800	86	1	73/07/16	89/01/18
		K	15	8.066700	63.35200	7.959400	30	1	77/06/07	86/10/15
		TOT	29	16.96600	429.7500	20.73000	86	1	73/07/16	89/01/18
01028 CD MUD DRY WGT MG/KG-CD	WATER		2	.1445000	.0182410	.1350600	.24	.05	81/05/19	83/05/10
		K	3	.2233300	.0234330	.1530800	.40	.13	81/11/10	91/08/14
		TOT	5	.1918000	.0181410	.1346900	.40	.05	81/05/19	91/08/14
01029 CHROMIUM SEDMG/KG DRY WGT	WATER		5	2.202000	2.500500	1.581300	4.70	.31	81/05/19	91/08/14
01034 CHROMIUM CR,TOT UG/L	WATER		34	25.77400	571.0100	23.89600	110	1	77/06/07	89/08/15
		K	25	20.24400	530.7700	23.03900	100	.1	77/08/09	90/06/19
		TOT	59	23.43100	552.1100	23.49700	110	.1	77/06/07	90/06/19
01042 COPPER CU,TOT UG/L	WATER		52	42.87900	796.4100	28.22100	103	4	73/07/16	90/01/24
		K	34	18.85300	216.8000	14.72400	56	1	77/09/13	90/06/19
		TOT	86	33.38000	701.6300	26.48800	103	1	73/07/16	90/06/19
01043 COPPER SEDMG/KG DRY WGT	WATER		5	3.496000	5.881100	2.425100	6.70	.38	81/05/19	91/08/14
01045 IRON FE,TOT UG/L	WATER		4	245.0000	16167.00	127.1500	400	110	83/11/08	86/10/15
01051 LEAD PB,TOT UG/L	WATER		43	64.72100	17317.00	131.5900	650	4	77/06/07	90/01/24
		K	40	18.59300	1023.200	31.98800	200	1	73/07/16	90/06/19
		TOT	83	42.49000	9893.900	99.46800	650	1	73/07/16	90/06/19
01052 LEAD SEDMG/KG DRY WGT	WATER		5	29.98000	493.3000	22.21000	64.00	3.90	81/05/19	91/08/14
01068 NICKEL SEDMG/KG DRY WGT	WATER	K	1	.8000000			.80	.80	91/08/14	91/08/14
01078 SILVER SEDMG/KG DRY WGT	WATER	K	1	.2000000			.20	.20	91/08/14	91/08/14
01092 ZINC ZN,TOT UG/L	WATER		58	41.82800	997.5500	31.58400	150	10	77/06/07	90/01/24
		K	25	14.60000	61.66700	7.852800	30	2	73/07/16	90/06/19
		TOT	83	33.62700	869.4100	29.48600	150	2	73/07/16	90/06/19
01093 ZINC SEDMG/KG DRY WGT	WATER		5	18.48000	112.2500	10.59500	30.00	3.40	81/05/19	91/08/14
01102 TIN SN,TOT UG/L	WATER	K	1	1000.000			1000	1000	84/05/15	84/05/15
01143 SILICON SILICATE UG/L SI	WATER	K	1	.1000000			.1	.1	83/05/10	83/05/10
01147 SELENIUM SE,TOT UG/L	WATER		3	.8666700	.5033300	.7094600	2	.1	79/05/09	87/05/20
		K	13	17.00000	804.8300	28.37000	100	2	77/07/12	88/07/22
		TOT	16	13.97500	686.2300	26.19600	100	.1	77/07/12	88/07/22
01148 SELENIUM SEDMG/KG DRY WGT	WATER		1	.0080000			.008	.008	81/05/19	81/05/19
		K	2	.7000000	.7200000	.8485300	1.30	.10	82/06/02	83/05/10

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AT OLD LAUNCH RAMP
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SANTA ANA RIVER BASIN
/TYPA/AMBNT/OCEAN BOLSA BAY
21CAOCFC 770817 HQ 18070201001 0007.630 OFF
0000 FEET DEPTH

PARAMETER		MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
01148	SELENIUM SEDMG/KG DRY WGT	WATER	TOT	3	.4693300	.5196200	.7208500	1.30	.008	81/05/19	83/05/10
31507	TOT COLI MPN COMP /100ML	WATER		19	4710.900	1944E+05	13946.00	49000	2	78/12/12	82/07/07
			K	13	476.9200	456920.0	675.9600	2000	200	80/01/22	81/11/10
			TOT	32	2990.900	1175E+05	10843.00	49000	2	78/12/12	82/07/07
32730	PHENOLS TOTAL UG/L	WATER	K	9	35.55600	302.7800	17.40100	50	10	78/04/11	82/11/09
34203	ACNAPTHY SEDUG/KG DRY WGT	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34208	ACNAPTHE SEDUG/KG DRY WGT	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34223	ANTHRACE SEDUG/KG DRY WGT	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34233	BENZBFLU ORANTMUD DRYUG/KG	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34245	BENZKFLU SEDUG/KG DRY WGT	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34250	BENZAPYR SEDUG/KG DRY WGT	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34257	BETA BHC SEDUG/KG DRY WGT	WATER	K	1	10.00000			10.000	10.000	91/08/14	91/08/14
34259	DELTABHC TOTUG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
34262	DELTABHC SEDUG/KG DRY WGT	WATER	K	1	10.00000			10.000	10.000	91/08/14	91/08/14
34323	CHRYSENE SEDUG/KG DRY WGT	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34337	DIETHYLP HTHALATE DISSUG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
34338	DIETHYLP HTHALATE SUSPUG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
34351	ENDSULSF TOTUG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
34354	ENDSULSF SEDUG/KG DRY WGT	WATER	K	1	10.00000			10.000	10.000	91/08/14	91/08/14
34356	B-ENDO SULFAN TOTWUG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
34359	BENDOSUL SEDUG/KG DRY WGT	WATER	K	1	10.00000			10.000	10.000	91/08/14	91/08/14
34361	A-ENDO SULFAN TOTWUG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
34364	AENDOSUL SEDUG/KG DRY WGT	WATER	K	1	10.00000			10.000	10.000	91/08/14	91/08/14
34369	ENDRINAL SEDUG/KG DRY WGT	WATER	K	1	10.00000			10.000	10.000	91/08/14	91/08/14
34379	FLANTENE SEDUG/KG DRY WGT	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34384	FLUORENE SEDUG/KG DRY WGT	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34406	I123CDPR SEDUG/KG DRY WGT	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34445	NAPTHALE SEDUG/KG DRY WGT	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34464	PHENANTH SEDUG/KG DRY WGT	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34472	PYRENE SEDUG/KG DRY WGT	WATER	K	1	.4000000			.400	.400	91/08/14	91/08/14
34529	BENZAANT SEDUG/KG DRY WGT	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34559	DBAHANTH SEDUG/KG DRY WGT	WATER	K	1	.2000000			.200	.200	91/08/14	91/08/14
34671	PCB 1016 TOTWUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/10	82/11/09
38260	MBAS MG/L	WATER		9	.2544500	.1181500	.3437300	1.10	.03	79/05/09	85/10/15
			K	4	.0550000	.0027000	.0519620	.10	.01	78/04/11	86/10/15
			TOT	13	.1930800	.0886230	.2977000	1.10	.01	78/04/11	86/10/15
39034	PERTHANE WHL SMPL UG/L	WATER	K	2	5.500000	40.50000	6.364000	10.000	1.000	81/11/10	82/11/09
39076	ALPHABHC SEDUG/KG DRY WGT	WATER	K	1	10.00000			10.000	10.000	91/08/14	91/08/14
39301	P,P'DDT SEDUG/KG DRY WGT	WATER	K	1	10.00000			10.00	10.00	91/08/14	91/08/14

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AT OLD LAUNCH RAMP
06059 CALIFORNIA ORANGE
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0000 FEET DEPTH

/TYPA/AMBNT/OCEAN

PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
39311 P,P'DDD SEDUG/KG DRY WGT	WATER	K	1	10.00000			10.00	10.00	91/08/14	91/08/14
39321 P,P'DDE SEDUG/KG DRY WGT	WATER	K	1	10.00000			10.00	10.00	91/08/14	91/08/14
39330 ALDRIN TOT UG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39333 ALDRIN SEDUG/KG DRY WGT	WATER	K	4	15.00000	33.33300	5.773500	20.00	10.00	81/05/19	91/08/14
39340 GAMMABHC LINDANE TOT.UG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39343 GBHC-MUD LINDANE DRYUG/KG	WATER	K	4	15.00000	33.33300	5.773500	20.00	10.00	81/05/19	91/08/14
39350 CHLRDANE TECH&MET TOT UG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39351 CDANEDRY TECH&MET MUDUG/KG	WATER	K	4	37.50000	1758.300	41.93300	100.00	10.00	81/05/19	91/08/14
39360 DDD WHL SMPL UG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39363 DDD MUD UG/KG	WATER	K	3	16.66700	33.33400	5.773600	20.00	10.00	81/05/19	82/06/02
39365 DDE WHL SMPL UG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39368 DDE MUD UG/KG	WATER	K	3	16.66700	33.33400	5.773600	20.00	10.00	81/05/19	82/06/02
39370 DDT WHL SMPL UG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39373 DDT MUD UG/KG	WATER	K	3	16.66700	33.33400	5.773600	20.00	10.00	81/05/19	82/06/02
39380 DIELDRIN TOTUG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39383 DIELDRIN SEDUG/KG DRY WGT	WATER	K	4	15.00000	33.33300	5.773500	20.00	10.00	81/05/19	91/08/14
39390 ENDRIN TOT UG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39393 ENDRIN SEDUG/KG DRY WGT	WATER	K	4	17.50000	25.00000	5.000000	20.00	10.00	81/05/19	91/08/14
39400 TOXAPHEN TOTUG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39403 TOXAPHEN SEDUG/KG DRY WGT	WATER	K	4	5012.500	99833000	9991.700	20000.00	10.00	81/05/19	91/08/14
39410 HEPTCHLR TOTUG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39413 HEPTCHLR SEDUG/KG DRY WGT	WATER	K	4	15.00000	33.33300	5.773500	20.00	10.00	81/05/19	91/08/14
39420 HPCHLREP TOTUG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39423 HPCHLREP SEDUG/KG DRY WGT	WATER	K	4	15.00000	33.33300	5.773500	20.00	10.00	81/05/19	91/08/14
39480 MTHXYCLR WHL SMPL UG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39481 MTHXYCLR MUD DRY UG/KG	WATER	K	4	30.00000	733.3300	27.08000	70.00	10.00	81/05/19	91/08/14
39488 PCB-1221 TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/10	82/11/09
39491 PCB-1221 SEDUG/KG DRY WGT	WATER	K	2	60.00000	3200.000	56.56900	100.00	20.00	82/06/02	91/08/14
39492 PCB-1232 TOTUG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39495 PCB-1232 SEDUG/KG DRY WGT	WATER	K	4	37.50000	1758.300	41.93300	100.00	10.00	81/05/19	91/08/14
39496 PCB-1242 TOTUG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39499 PCB-1242 SEDUG/KG DRY WGT	WATER	K	4	37.50000	1758.300	41.93300	100.00	10.00	81/05/19	91/08/14
39500 PCB-1248 TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/10	82/11/09
39503 PCB-1248 SEDUG/KG DRY WGT	WATER	K	2	60.00000	3200.000	56.56900	100.00	20.00	82/06/02	91/08/14
39504 PCB-1254 TOTUG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39507 PCB-1254 SEDUG/KG DRY WGT	WATER	K	4	37.50000	1758.300	41.93300	100.00	10.00	81/05/19	91/08/14
39508 PCB-1260 TOTUG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39511 PCB-1260 SEDUG/KG DRY WGT	WATER	K	4	37.50000	1758.300	41.93300	100.00	10.00	81/05/19	91/08/14
39514 PCB-1016 SEDUG/KG DRY WGT	WATER	K	1	100.0000			100.00	100.00	91/08/14	91/08/14

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/TYPA/AMBNT/OCEAN

PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
39530 MALATHN WHL SMPL UG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
39531 MALATHN MUD UG/KG	WATER	K	2	25.00000	50.00000	7.071100	30.00	20.00	81/11/10	91/08/14
39540 PARATHN WHL SMPL UG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
39541 PARATHN MUD UG/KG	WATER	K	2	25.00000	50.00000	7.071100	30.00	20.00	81/11/10	91/08/14
39730 2,4-D WHL SMPL UG/L	WATER	K	3	10.00000	.0000000	.0000000	10.000	10.000	81/11/10	82/11/09
39731 2,4-D MUD UG/KG	WATER	K	4	1325.000	6002500	2450.000	5000.00	100.00	81/11/01	91/08/14
39760 SILVEX WHL SMPL UG/L	WATER	K	3	10.00000	.0000000	.0000000	10.000	10.000	81/11/10	82/11/09
39761 SILVEX MUD UG/KG	WATER	K	4	575.0000	902500.0	950.0000	2000.00	100.00	81/11/01	91/08/14
39782 LINDANE WHL SMPL UG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	81/05/19	82/11/09
39783 LINDANE MUD DRY UG/KG	WATER	K	3	16.66700	33.33400	5.773600	20.00	10.00	81/05/19	82/06/02
71850 NITRATE TOT-NO3 MG/L	WATER		49	3.595700	25.28300	5.028200	20.8	.1	77/07/12	91/08/14
		K	42	.4338100	.4105000	.6407000	4.4	.01	77/06/07	90/06/19
		TOT	91	2.136400	16.18300	4.022900	20.8	.01	77/06/07	91/08/14
71885 IRON FE UG/L	WATER		1	150.0000			150.00	150.00	77/07/12	77/07/12
71900 MERCURY HG,TOTAL UG/L	WATER		4	5.050000	10.81000	3.287900	9.0	1.2	79/05/09	82/06/02
		K	10	.9000000	.6200000	.7874000	3.0	.2	77/07/12	88/07/22
		TOT	14	2.085700	6.709000	2.590200	9.0	.2	77/07/12	88/07/22
71921 MERCURY SEDMG/KG DRY WGT	WATER		2	.0245000	.0003125	.0176780	.04	.01	81/11/10	82/06/02
		K	2	.0550000	.0040500	.0636400	.1	.01	81/05/19	83/05/10
		TOT	4	.0397500	.0017643	.0420030	.1	.01	81/05/19	83/05/10
74041 WQF SAMPLE UPDATED	WATER		35	887490.0	1371E+05	11712.00	920109	860729	85/10/15	91/08/14
78453 PCB-1262 SED DRY WT UG/KG	WATER	K	1	100.0000			100.000	100.000	91/08/14	91/08/14
78828 BZO(GHI) PERYLENE SEDUG/KG	WATER	K	1	.2000000			.20	.20	91/08/14	91/08/14
81886 PERTHANE SED DRY WGTUG/KG	WATER	K	3	23347.00	1632E+06	40403.00	70000.00	20.000	81/11/01	91/08/14
82007 % SAND IN SED DRY WGT	WATER		1	1.200000			1.20	1.20	82/06/02	82/06/02
82008 SEDIMENT PARTSIZE SILT	WATER		1	92.60000			92.60	92.60	82/06/02	82/06/02
82009 SEDIMENT PARTSIZE CLAY	WATER		1	6.200000			6.20	6.20	82/06/02	82/06/02

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WARNER AVE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140792
EAST GARDEN GROVE WINTERS- BURG CHANNEL
21CAOCFC 18070201
0999 FEET DEPTH

/TYPA/AMBNT/STREAM

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER		8	17.87500	28.69700	5.356900	26.0	11.0	73/12/03	74/08/06
00011	WATER	TEMP	FAHN	WATER	$	8	64.17500	92.98300	9.642800	78.8	51.8	73/12/03	74/08/06
00061	STREAM	FLOW,	INST-CFS	WATER	J	4	86.25000	7289.600	85.37900	200	5	74/01/04	74/06/03
00095	CNDUCTVY	AT 25C	MICROMHO	WATER		10	3451.000	25791000	5078.500	13020	164	73/04/06	74/08/06
00310	BOD	5 DAY	MG/L	WATER		2	4.800000	1.280000	1.131400	5.6	4.0	73/12/03	74/01/07
00403	PH	LAB	SU	WATER		10	7.710000	.2966000	.5446100	8.4	6.9	73/04/06	74/08/06
00530	RESIDUE	TOT NFLT	MG/L	WATER		8	230.5500	63974.00	252.9300	720	27	73/12/03	74/08/06
00550	OIL-GRSE	TOT-SXLT	MG/L	WATER		2	22.50000	856.9800	29.27400	43.2	1.8	74/01/07	74/07/09
00610	NH3+NH4-	N TOTAL	MG/L	WATER		4	.5600000	.6858700	.8281700	1.800	.080	74/01/04	74/08/06
					K	6	.1666700	.0066667	.0816500	.300	.100	73/04/06	74/07/09
					TOT	10	.3240000	.2735800	.5230500	1.800	.080	73/04/06	74/08/06
00612	UN-IONZD	NH3-N	MG/L	WATER	$	8	.0133080	.0010058	.0317140	.092	.0005	73/12/03	74/08/06
00619	UN-IONZD	NH3-NH3	MG/L	WATER	$	8	.0161810	.0014869	.0385610	.111	.0006	73/12/03	74/08/06
00625	TOT KJEL	N	MG/L	WATER		7	2.471400	1.187200	1.089600	3.880	1.600	73/12/03	74/08/06
					K	1	.1000000			.100	.100	74/07/09	74/07/09
					TOT	8	2.175000	1.720600	1.311700	3.880	.100	73/12/03	74/08/06
00650	T PO4	PO4	MG/L	WATER		10	.7010000	.3180600	.5639600	1.73	.06	73/04/06	74/08/06
00955	SILICA	DISOLVED	MG/L	WATER		10	5.110000	9.252200	3.041700	11.8	1.1	73/04/06	74/08/06
01002	ARSENIC	AS,TOT	UG/L	WATER	K	2	.7500000	.1250000	.3535500	1	.5	74/01/07	74/07/09
01027	CADMIUM	CD,TOT	UG/L	WATER		2	5.000000	18.00000	4.242600	8	2	74/01/07	74/07/09
01034	CHROMIUM	CR,TOT	UG/L	WATER		1	10.00000			10	10	74/07/09	74/07/09
01042	COPPER	CU,TOT	UG/L	WATER		1	20.00000			20	20	74/07/09	74/07/09
					K	1	12.00000			12	12	74/01/07	74/01/07
					TOT	2	16.00000	32.00000	5.656900	20	12	74/01/07	74/07/09
01045	IRON	FE,TOT	UG/L	WATER		2	3275.000	9901300	3146.600	5500	1050	74/01/07	74/07/09
01051	LEAD	PB,TOT	UG/L	WATER		4	130.2800	29398.00	171.4600	380	.1	73/12/03	74/07/09
01092	ZINC	ZN,TOT	UG/L	WATER		2	79.50000	112.5000	10.60700	87	72	74/01/07	74/07/09
01147	SELENIUM	SE,TOT	UG/L	WATER		2	8.700000	56.18000	7.495300	14	3	74/01/07	74/07/09
39330	ALDRIN		TOT UG/L	WATER	K	1	.0100000			.010	.010	74/01/07	74/01/07
39340	GAMMABHC	LINDANE	TOT.UG/L	WATER		1	.4000000			.400	.400	74/01/07	74/01/07
39350	CHLRDANE	TECH&MET	TOT UG/L	WATER	K	1	.6000000			.600	.600	74/01/07	74/01/07
39360	DDD	WHL SMPL	UG/L	WATER	K	1	.0100000			.010	.010	74/01/07	74/01/07
39365	DDE	WHL SMPL	UG/L	WATER	K	1	.0100000			.010	.010	74/01/07	74/01/07
39370	DDT	WHL SMPL	UG/L	WATER	K	1	.0100000			.010	.010	74/01/07	74/01/07
39380	DIELDRIN		TOTUG/L	WATER	K	1	.0500000			.050	.050	74/01/07	74/01/07
39390	ENDRIN		TOT UG/L	WATER	K	1	.1000000			.100	.100	74/01/07	74/01/07
39410	HEPTCHLR		TOTUG/L	WATER		1	.5400000			.540	.540	74/01/07	74/01/07
39420	HPCHLREP		TOTUG/L	WATER	K	1	.0200000			.020	.020	74/01/07	74/01/07
39480	MTHXYCLR	WHL SMPL	UG/L	WATER	K	1	.0500000			.050	.050	74/01/07	74/01/07

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21CAOCFC 18070201
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/TYPA/AMBNT/STREAM

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
39780	DICOFOL	WHL SMPL	UG/L	WATER	K	1	.0100000			.010	.010	74/01/07	74/01/07
39782	LINDANE	WHL SMPL	UG/L	WATER	K	1	.0200000			.020	.020	74/01/07	74/01/07
71850	NITRATE	TOT-NO3	MG/L	WATER		10	19.81000	312.0300	17.66500	50.6	3.5	73/04/06	74/08/06
71900	MERCURY	HG,TOTAL	UG/L	WATER	K	2	1.250000	1.125000	1.060700	2.0	.5	74/01/07	74/07/09

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100 YARDS NORTH OF WARNER AVENUE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
HUNTINGTON HARBOUR
21CAOCFC 770210 HQ 18070201001 0008.910 OFF
0999 FEET DEPTH

/TYPA/AMBNT/ESTURY

	PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER TEMP CENT	BOTTOM		1	21.50000			21.5	21.5	91/08/13	91/08/13
		WATER		343	19.39600	11.65300	3.413600	27.1	10.0	76/11/22	91/08/13
00011	WATER TEMP FAHN	BOTTOM	$	1	70.70000			70.7	70.7	91/08/13	91/08/13
		WATER	$	343	66.91300	37.76000	6.144900	80.8	50.0	76/11/22	91/08/13
00035	WIND VELOCITY MPH	WATER		69	4.144900	8.743400	2.956900	10.0	.0	77/12/14	91/08/13
00036	WIND DIR.FROM NORTH-0	WATER		57	225.4400	2179.800	46.68800	315	90	78/12/13	91/08/13
00065	STREAM STAGE FEET	WATER		98	2.998000	2.433800	1.560100	7.00	.00	76/11/22	88/03/24
00067	TIDE STAGE CODE	WATER		98	3496.900	5480800	2341.100	7610	.5	76/11/22	88/03/24
00076	TURB TRBIDMTR HACH FTU	WATER		105	2.539100	26.25100	5.123500	45.0	.1	76/11/22	91/08/13
00078	TRANSP SECCHI METERS	WATER		27	1.400000	.1340400	.3661200	2.50	1.00	84/08/22	91/08/13
			L	3	1.166700	.5833400	.7637700	2.00	.50	84/05/22	86/03/20
			TOT	30	1.376700	.1654800	.4067900	2.50	.50	84/05/22	91/08/13
00094	CNDUCTVY FIELD MICROMHO	BOTTOM		1	51500.00			51500	51500	91/08/13	91/08/13
		WATER		335	47391.00	18643000	4317.800	55700	12400	77/01/27	91/08/13
00095	CNDUCTVY AT 25C MICROMHO	WATER		103	43461.00	45436000	6740.600	69000	13300	76/11/22	91/08/13
00116	INTNSVE SURVEY IDENT	WATER		2	730600.0	.0000000	.0000000	730601	730601	78/02/16	79/01/10
00300	DO MG/L	BOTTOM		1	5.200000			5.2	5.2	91/08/13	91/08/13
		WATER		334	6.787700	2.149000	1.465900	19.2	3.7	76/12/21	91/08/13
			L	1	15.00000			15.0	15.0	76/11/22	76/11/22
			TOT	335	6.812200	2.343900	1.531000	19.2	3.7	76/11/22	91/08/13
00301	DO SATUR PERCENT	BOTTOM	$	1	57.77800			57.8	57.8	91/08/13	91/08/13
		WATER	$	333	73.09300	272.2500	16.50000	213.3	42.0	76/11/22	91/08/13
00310	BOD 5 DAY MG/L	WATER		4	5.250000	11.58300	3.403400	10.0	2.0	78/04/12	79/10/10
00335	COD LOWLEVEL MG/L	WATER		27	278.3700	80826.00	284.3000	1370.0	31.0	77/06/08	79/05/10
			K	2	20.00000	.0000000	.0000000	20.0	20.0	77/08/10	77/09/14
			TOT	29	260.5500	79492.00	281.9400	1370.0	20.0	77/06/08	79/05/10
00400	PH SU	BOTTOM		1	7.500000			7.50	7.50	91/08/13	91/08/13
		WATER		337	7.906200	.0841590	.2901000	9.50	6.80	76/11/22	91/08/13
00403	PH LAB SU	WATER		103	7.852800	.0552240	.2350000	8.3	6.8	76/11/22	91/08/13
00530	RESIDUE TOT NFLT MG/L	WATER		86	46.57100	10895.00	104.3800	700	2	76/11/22	91/08/13
			K	18	4.483300	2.263800	1.504600	5	.2	80/01/24	90/04/12
			TOT	104	39.28700	9247.200	96.16200	700	.2	76/11/22	91/08/13
00535	RESIDUE VOL NFLT MG/L	WATER		72	21.55800	1432.800	37.85300	250	.2	77/04/13	90/06/21
			K	28	3.517900	4.817800	2.195000	5	.1	78/12/13	91/08/13
			TOT	100	16.50700	1095.200	33.09300	250	.1	77/04/13	91/08/13
00550	OIL-GRSE TOT-SXLT MG/L	WATER		12	12.72700	377.6300	19.43300	70.0	.4	78/04/12	85/10/16
			K	3	3.500000	6.750000	2.598100	5.0	.5	79/05/10	86/10/15
			TOT	15	10.88100	312.2700	17.67100	70.0	.4	78/04/12	86/10/15
00610	NH3+NH4- N TOTAL MG/L	WATER		72	.4291600	.1775600	.4213800	3.100	.060	76/11/22	91/08/13

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00610	NH3+NH4-	N TOTAL	MG/L	WATER	K	32	.1125000	.0050001	.0707110	.500	.100	76/12/21	85/05/22
00610	NH3+NH4-	N TOTAL	MG/L	WATER	TOT	104	.3317300	.1454700	.3814000	3.100	.060	76/11/22	91/08/13
00612	UN-IONZD	NH3-N	MG/L	WATER	$	93	.0122370	.0002066	.0143740	.088	.0004	76/11/22	91/08/13
00619	UN-IONZD	NH3-NH3	MG/L	WATER	$	93	.0148790	.0003054	.0174770	.107	.0005	76/11/22	91/08/13
00625	TOT KJEL	N	MG/L	WATER		98	1.076600	1.033800	1.016800	7.600	.100	76/11/22	90/06/21
					K	6	.1833300	.0256670	.1602100	.500	.100	77/08/10	91/08/13
					TOT	104	1.025100	1.018600	1.009300	7.600	.100	76/11/22	91/08/13
00650	T PO4	PO4	MG/L	WATER		80	.3236200	.0364880	.1910200	1.20	.03	76/11/22	91/08/13
					K	25	.2934000	.0460980	.2147000	.50	.01	77/08/10	90/01/25
					TOT	105	.3164300	.0385220	.1962700	1.20	.01	76/11/22	91/08/13
00668	PHOS MUD	DRY WGT	MG/KG-P	WATER		9	293.4100	156740.0	395.9000	980.0	.8	78/04/12	85/10/16
00680	T ORG C	C	MG/L	WATER		3	2335.000	16322000	4040.100	7000.0	1.3	83/11/09	86/10/15
00721	CYANIDE	SEDMG/KG	DRY WGT	WATER	K	1	.0300000			.03	.03	80/10/15	80/10/15
00745	SULFIDE	TOTAL	MG/L	WATER		1	.0000000			.00	.00	84/05/22	84/05/22
00747	SULFIDE	IN SED.	MG/KG	WATER		4	21.47500	1523.400	39.03000	80.00	1.00	82/11/10	84/05/22
					K	4	.9500000	.4300000	.6557400	1.70	.10	80/10/15	85/10/16
					TOT	8	11.21300	773.4200	27.81100	80.00	.10	80/10/15	85/10/16
00955	SILICA	DISOLVED	MG/L	WATER		41	1.281500	1.327600	1.152200	5.3	.1	76/11/22	80/10/15
					K	9	.6333300	.1325000	.3640100	1.0	.2	77/09/14	80/11/13
					TOT	50	1.164800	1.168700	1.081100	5.3	.1	76/11/22	80/11/13
01002	ARSENIC	AS,TOT	UG/L	WATER		7	9.342900	196.3300	14.01200	40	1	78/11/08	87/05/21
					K	15	9.866700	52.26700	7.229600	28	2	77/07/13	89/01/19
					TOT	22	9.700000	91.00000	9.539400	40	1	77/07/13	89/01/19
01003	ARSENIC	SEDMG/KG	DRY WGT	WATER		18	4.201700	15.58100	3.947300	16.00	.76	78/04/12	89/01/19
01019	CD MUD	WET WGTM	G/KG-CD	WATER		1	1.190000			1.19	1.19	78/04/12	78/04/12
01020	BORON	B,DISS	UG/L	WATER		1	7100.000			7100	7100	78/08/09	78/08/09
01027	CADMIUM	CD,TOT	UG/L	WATER		18	8.900000	126.2000	11.23400	41	1	76/12/21	89/01/19
					K	23	7.543500	57.74800	7.599200	30	.5	76/11/22	88/10/14
					TOT	41	8.139000	85.86300	9.266200	41	.5	76/11/22	89/01/19
01028	CD MUD	DRY WGT	MG/KG-CD	BOTTOM	K	1	.4000000			.40	.40	91/08/13	91/08/13
				WATER		13	.6156900	.2166700	.4654700	1.60	.12	78/04/12	89/01/19
					K	5	.5500000	.0758010	.2753200	.90	.20	80/05/14	84/12/12
					TOT	18	.5974400	.1716900	.4143600	1.60	.12	78/04/12	89/01/19
01029	CHROMIUM	SEDMG/KG	DRY WGT	BOTTOM		1	12.00000			12.00	12.00	91/08/13	91/08/13
				WATER		20	10.13000	28.52400	5.340800	22.00	3.30	78/04/12	90/01/25
01034	CHROMIUM	CR,TOT	UG/L	WATER		42	22.23100	688.5100	26.24000	120	1	77/06/08	89/08/16
					K	36	13.65000	230.5600	15.18400	60	.1	76/11/22	90/06/21
					TOT	78	18.27100	489.9500	22.13500	120	.1	76/11/22	90/06/21
01039	CU MUD	WET WGTM	G/KG-CU	WATER		1	493.0000			493.00	493.00	78/04/12	78/04/12

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01042	COPPER	CU,TOT	UG/L	WATER		55	40.31600	925.3400	30.41900	140	1	77/02/09	90/06/21
					K	46	19.52200	288.9200	16.99800	70	1	77/09/14	90/04/12
					TOT	101	30.84600	738.0200	27.16700	140	1	77/02/09	90/06/21
01043	COPPER	SEDMG/KG	DRY WGT	BOTTOM		1	26.00000			26.00	26.00	91/08/13	91/08/13
				WATER		20	71.95500	26741.00	163.5300	600.00	3.70	78/04/12	90/01/25
01045	IRON	FE,TOT	UG/L	WATER		5	176.2000	10937.00	104.5800	330	91	83/11/09	86/10/15
01051	LEAD	PB,TOT	UG/L	WATER		45	16.53300	224.6200	14.98700	70	1	76/12/21	89/08/16
					K	60	19.40000	1679.000	40.97600	200	1	76/11/22	90/06/21
					TOT	105	18.17200	1049.600	32.39700	200	1	76/11/22	90/06/21
01052	LEAD	SEDMG/KG	DRY WGT	BOTTOM		1	34.00000			34.00	34.00	91/08/13	91/08/13
				WATER		18	71.71100	4311.800	65.66400	280.00	8.60	78/04/12	90/01/25
01068	NICKEL	SEDMG/KG	DRY WGT	BOTTOM		1	9.200000			9.20	9.20	91/08/13	91/08/13
01078	SILVER	SEDMG/KG	DRY WGT	BOTTOM	K	1	.2000000			.20	.20	91/08/13	91/08/13
01092	ZINC	ZN,TOT	UG/L	WATER		78	42.61000	2304.700	48.00800	380	7	76/11/22	90/01/25
					K	27	21.81500	724.2400	26.91200	150	5	77/04/13	90/06/21
					TOT	105	37.26300	1970.900	44.39400	380	5	76/11/22	90/06/21
01093	ZINC	SEDMG/KG	DRY WGT	BOTTOM		1	120.0000			120.00	120.00	91/08/13	91/08/13
				WATER		21	89.23800	2602.800	51.01800	210.00	19.00	78/04/12	90/01/25
01102	TIN	SN,TOT	UG/L	WATER	K	6	1941.700	3825400	1955.900	5000	20	79/05/10	86/10/15
01103	TIN MUD	DRY WGT	MG/KG-SN	WATER		1	13.00000			13.00	13.00	79/05/10	79/05/10
					K	2	105.0000	800.0000	28.28400	125.00	85.00	84/12/12	85/10/16
					TOT	3	74.33300	3221.300	56.75700	125.00	13.00	79/05/10	85/10/16
01143	SILICON	SILICATE	UG/L SI	WATER	K	3	1.166700	.9433400	.9712600	2	.1	83/05/11	84/12/12
01147	SELENIUM	SE,TOT	UG/L	WATER		5	19.00000	690.0000	26.26800	65	2	77/07/13	86/10/15
					K	15	18.97300	1447.600	38.04700	150	.1	78/11/08	89/07/13
					TOT	20	18.98000	1211.900	34.81300	150	.1	77/07/13	89/07/13
01148	SELENIUM	SEDMG/KG	DRY WGT	WATER		4	.6975000	.1511600	.3887900	1.03	.29	78/04/12	81/05/20
					K	11	1.034600	2.076700	1.441100	5.00	.05	78/11/08	85/10/16
					TOT	15	.9446700	1.539600	1.240800	5.00	.05	78/04/12	85/10/16
01170	FE MUD	DRY WGT	MG/KG-FE	WATER		3	20367.00	99204000	9960.100	28000.00	9100.00	83/11/09	85/10/16
					K	1	.4000000			.40	.40	89/07/13	89/07/13
					TOT	4	15275.00	1698E+05	13032.00	28000.00	.40	83/11/09	89/07/13
32730	PHENOLS	TOTAL	UG/L	WATER		1	110.0000			110	110	77/07/13	77/07/13
					K	10	30.00000	311.1100	17.63800	50	10	78/04/12	82/11/10
					TOT	11	37.27300	861.8200	29.35700	110	10	77/07/13	82/11/10
34203	ACNAPTHY	SEDUG/KG	DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34208	ACNAPTHE	SEDUG/KG	DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34223	ANTHRACE	SEDUG/KG	DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34233	BENZBFLU	ORANTMUD	DRYUG/KG	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13

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34245 BENZKFLU SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34250 BENZAPYR SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34257 BETA BHC SEDUG/KG DRY WGT	BOTTOM	K	1	1.000000			1.000	1.000	91/08/13	91/08/13
	WATER	K	7	10.00000	33.32700	5.772900	20.000	.002	82/11/10	89/01/19
34259 DELTABHC TOTUG/L	WATER	K	10	1.132200	9.800200	3.130500	10.000	.002	82/11/10	89/01/19
34262 DELTABHC SEDUG/KG DRY WGT	BOTTOM	K	1	1.000000			1.000	1.000	91/08/13	91/08/13
	WATER	K	7	10.00000	33.32700	5.772900	20.000	.002	82/11/10	89/01/19
34323 CHRYSENE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34337 DIETHYLP HTHALATE DISSUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34338 DIETHYLP HTHALATE SUSPUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34351 ENDSULSF TOTUG/L	WATER	K	10	1.200300	9.654200	3.107100	10.000	.003	82/11/10	89/01/19
34354 ENDSULSF SEDUG/KG DRY WGT	BOTTOM	K	1	1.000000			1.000	1.000	91/08/13	91/08/13
	WATER	K	7	28.57200	314.2600	17.72700	50.000	.003	82/11/10	89/01/19
34356 B-ENDO SULFAN TOTWUG/L	WATER	K	10	.6522000	2.427400	1.558000	5.000	.002	82/11/10	89/01/19
34359 BENDOSUL SEDUG/KG DRY WGT	BOTTOM	K	1	1.000000			1.000	1.000	91/08/13	91/08/13
	WATER	K	7	12.85800	90.46800	9.511500	30.000	.002	82/11/10	89/01/19
34361 A-ENDO SULFAN TOTWUG/L	WATER		1	.0030000			.003	.003	89/01/19	89/01/19
		K	9	1.280000	10.79400	3.285500	10.000	.010	82/11/10	88/01/21
		TOT	10	1.152300	9.758000	3.123800	10.000	.003	82/11/10	89/01/19
34364 AENDOSUL SEDUG/KG DRY WGT	BOTTOM	K	1	1.000000			1.000	1.000	91/08/13	91/08/13
	WATER		1	.0030000			.003	.003	89/01/19	89/01/19
		K	6	15.00000	70.00000	8.366600	30.000	10.000	82/11/10	88/01/21
		TOT	7	12.85800	90.46400	9.511200	30.000	.003	82/11/10	89/01/19
34369 ENDRINAL SEDUG/KG DRY WGT	BOTTOM	K	1	1.000000			1.000	1.000	91/08/13	91/08/13
34379 FLANTENE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34384 FLUORENE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34406 I123CDPR SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34445 NAPTHALE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34464 PHENANTH SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34472 PYRENE SEDUG/KG DRY WGT	BOTTOM	K	1	.4000000			.400	.400	91/08/13	91/08/13
34529 BENZAANT SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34559 DBAHANTH SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34671 PCB 1016 TOTWUG/L	WATER	K	12	25.88600	7452.300	86.32700	300.000	.030	81/11/12	89/01/19
38260 MBAS MG/L	WATER		4	.3225000	.2701600	.5197700	1.10	.01	80/10/15	84/05/22
		K	8	.0662500	.0021697	.0465800	.10	.01	79/05/10	86/10/15
		TOT	12	.1516700	.0909790	.3016300	1.10	.01	79/05/10	86/10/15
39034 PERTHANE WHL SMPL UG/L	WATER	K	14	10.03600	730.7800	27.03300	100.000	.003	79/05/10	89/01/19
39046 SIMAZINE MUD UG/GK	WATER	K	8	763.1400	3049200	1746.200	5000.00	.10	79/05/10	89/01/19
39055 SIMAZINE WH.WATER (UG/L)	WATER	K	11	15.14600	1008.300	31.75400	100	.1	79/05/10	89/01/19

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39076 ALPHABHC SEDUG/KG DRY WGT	BOTTOM	K	1	1.000000			1.000	1.000	91/08/13	91/08/13
	WATER	K	6	10.00000	30.00000	5.477200	20.000	5.000	82/11/10	88/01/21
39301 P,P'DDT SEDUG/KG DRY WGT	BOTTOM	K	1	1.000000			1.00	1.00	91/08/13	91/08/13
39311 P,P'DDD SEDUG/KG DRY WGT	BOTTOM	K	1	1.000000			1.00	1.00	91/08/13	91/08/13
39321 P,P'DDE SEDUG/KG DRY WGT	BOTTOM	K	1	1.000000			1.00	1.00	91/08/13	91/08/13
39330 ALDRIN TOT UG/L	WATER		1	.0040000			.004	.004	89/01/19	89/01/19
		K	19	.7136800	1.298100	1.139300	5.000	.005	77/07/13	88/01/21
		TOT	20	.6782000	1.254900	1.120200	5.000	.004	77/07/13	89/01/19
39333 ALDRIN SEDUG/KG DRY WGT	BOTTOM	K	1	1.000000			1.00	1.00	91/08/13	91/08/13
	WATER		1	.0040000			.004	.004	89/01/19	89/01/19
		K	13	11.19200	45.56400	6.750100	20.00	.50	78/11/08	88/01/21
		TOT	14	10.39300	51.00100	7.141500	20.00	.004	78/11/08	89/01/19
39337 ALPHABHC TOTUG/L	WATER	K	9	1.140200	11.03900	3.322500	10.000	.002	83/11/09	89/01/19
39338 BETA BHC TOTUG/L	WATER	K	9	1.146900	11.02300	3.320100	10.000	.002	83/11/09	89/01/19
39340 GAMMABHC LINDANE TOT.UG/L	WATER	K	14	.6035700	.2259500	.4753400	1.000	.050	77/07/13	84/12/12
39343 GBHC-MUD LINDANE DRYUG/KG	BOTTOM	K	1	1.000000			1.00	1.00	91/08/13	91/08/13
	WATER	K	10	12.55000	50.02500	7.072800	20.00	.50	78/11/08	84/12/12
39350 CHLRDANE TECH&MET TOT UG/L	WATER	K	20	5.535500	494.5600	22.23900	100.000	.010	77/07/13	89/01/19
39351 CDANEDRY TECH&MET MUDUG/KG	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
	WATER		1	69.00000			69.00	69.00	80/05/14	80/05/14
		K	13	37.34700	1524.400	39.04400	100.00	.01	78/11/08	89/01/19
		TOT	14	39.60800	1478.700	38.45400	100.00	.01	78/11/08	89/01/19
39360 DDD WHL SMPL UG/L	WATER	K	20	.9311000	4.774300	2.185000	10.000	.002	77/07/13	89/01/19
39363 DDD MUD UG/KG	WATER	K	14	11.10700	46.00400	6.782600	20.00	.002	78/11/08	89/01/19
39365 DDE WHL SMPL UG/L	WATER		2	19.50900	759.8400	27.56500	39.000	.017	86/10/15	89/01/19
		K	18	.4788900	.2307200	.4803300	1.000	.010	77/07/13	88/01/21
		TOT	20	2.381900	74.50500	8.631600	39.000	.010	77/07/13	89/01/19
39368 DDE MUD UG/KG	WATER		1	30.00000			30.00	30.00	84/05/22	84/05/22
		K	13	11.19400	49.69900	7.049800	20.00	.02	78/11/08	89/01/19
		TOT	14	12.53700	71.13900	8.434400	30.00	.02	78/11/08	89/01/19
39370 DDT WHL SMPL UG/L	WATER		1	140.0000			140.000	140.000	86/10/15	86/10/15
		K	19	.4706300	.2168000	.4656200	1.000	.002	77/07/13	89/01/19
		TOT	20	7.447100	973.6300	31.20300	140.000	.002	77/07/13	89/01/19
39373 DDT MUD UG/KG	WATER	K	14	16.10700	91.77100	9.579700	30.00	.002	78/11/08	89/01/19
39380 DIELDRIN TOTUG/L	WATER	K	20	.6811000	1.251200	1.118600	5.000	.002	77/07/13	89/01/19
39381 DIELDRIN DISUG/L	WATER	K	1	20.00000			20.000	20.000	80/05/14	80/05/14
39383 DIELDRIN SEDUG/KG DRY WGT	BOTTOM	K	1	1.000000			1.00	1.00	91/08/13	91/08/13
	WATER	K	14	11.10700	46.00400	6.782600	20.00	.002	78/11/08	89/01/19
39390 ENDRIN TOT UG/L	WATER	K	20	.9411500	4.756100	2.180800	10.000	.003	77/07/13	89/01/19

HUNWAR
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100 YARDS NORTH OF WARNER AVENUE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
/TYPA/AMBNT/ESTURY
HUNTINGTON HARBOUR
21CAOCFC 770210 HQ 18070201001 0008.910 OFF
0999 FEET DEPTH

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
39393	ENDRIN	SEDUG/KG	DRY WGT	BOTTOM	K	1	2.000000			2.00	2.00	91/08/13	91/08/13
				WATER	K	14	13.96500	76.55000	8.749300	30.00	.003	78/11/08	89/01/19
39400	TOXAPHEN		TOTUG/L	WATER	K	20	25.91800	12453.00	111.5900	500.000	.050	77/07/13	89/01/19
39403	TOXAPHEN	SEDUG/KG	DRY WGT	BOTTOM	K	1	200.0000			200.00	200.00	91/08/13	91/08/13
				WATER	K	13	138.1200	36977.00	192.3000	500.00	.05	78/11/08	89/01/19
39410	HEPTCHLR		TOTUG/L	WATER	K	20	.6811500	1.251100	1.118500	5.000	.003	77/07/13	89/01/19
39413	HEPTCHLR	SEDUG/KG	DRY WGT	BOTTOM	K	1	1.000000			1.00	1.00	91/08/13	91/08/13
				WATER	K	14	11.10700	46.00200	6.782500	20.00	.003	78/11/08	89/01/19
39420	HPCHLREP		TOTUG/L	WATER	K	20	.9311000	4.774300	2.185000	10.000	.002	77/07/13	89/01/19
39423	HPCHLREP	SEDUG/KG	DRY WGT	BOTTOM	K	1	1.000000			1.00	1.00	91/08/13	91/08/13
				WATER	K	14	11.10700	46.00400	6.782600	20.00	.002	78/11/08	89/01/19
39480	MTHXYCLR	WHL SMPL	UG/L	WATER	K	17	6.547700	580.1000	24.08500	100.000	.010	79/05/10	89/01/19
39481	MTHXYCLR	MUD DRY	UG/KG	BOTTOM	K	1	7.000000			7.00	7.00	91/08/13	91/08/13
				WATER	K	11	40.91000	1589.000	39.86300	100.00	.01	79/10/10	89/01/19
39488	PCB-1221		TOTUG/L	WATER	K	12	25.88600	7452.300	86.32700	300.000	.030	81/11/12	89/01/19
39491	PCB-1221	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
				WATER	K	7	188.5800	20246.00	142.2900	300.00	.03	81/11/12	89/01/19
39492	PCB-1232		TOTUG/L	WATER	K	20	15.88700	4472.400	66.87600	300.000	.030	77/07/13	89/01/19
39495	PCB-1232	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
				WATER	K	14	100.4000	17748.00	133.2200	300.00	.03	78/11/08	89/01/19
39496	PCB-1242		TOTUG/L	WATER	K	20	15.88700	4472.400	66.87600	300.000	.030	77/07/13	89/01/19
39499	PCB-1242	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
				WATER	K	14	100.4000	17748.00	133.2200	300.00	.03	78/11/08	89/01/19
39500	PCB-1248		TOTUG/L	WATER	K	12	25.88600	7452.300	86.32700	300.000	.030	81/11/12	89/01/19
39503	PCB-1248	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
				WATER	K	6	216.6700	17664.00	132.9100	300.00	.03	84/05/22	89/01/19
39504	PCB-1254		TOTUG/L	WATER	K	20	15.88700	4472.400	66.87600	300.000	.030	77/07/13	89/01/19
39507	PCB-1254	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
				WATER	K	14	100.4000	17748.00	133.2200	300.00	.03	78/11/08	89/01/19
39508	PCB-1260		TOTUG/L	WATER	K	20	15.88700	4472.400	66.87600	300.000	.030	77/07/13	89/01/19
39511	PCB-1260	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
				WATER	K	14	100.4000	17748.00	133.2200	300.00	.03	78/11/08	89/01/19
39514	PCB-1016	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
				WATER	K	7	188.5800	20246.00	142.2900	300.00	.03	81/11/12	89/01/19
39530	MALATHN	WHL SMPL	UG/L	WATER	K	13	9.234600	750.1200	27.38800	100.000	.050	79/05/10	89/01/19
39531	MALATHN	MUD	UG/KG	BOTTOM	K	1	30.00000			30.00	30.00	91/08/13	91/08/13
				WATER	K	10	129.5100	94890.00	308.0400	1000.00	.05	79/05/10	89/01/19
39540	PARATHN	WHL SMPL	UG/L	WATER	K	13	16.15800	1384.700	37.21100	100.000	.050	79/05/10	89/01/19
39541	PARATHN	MUD	UG/KG	BOTTOM	K	1	30.00000			30.00	30.00	91/08/13	91/08/13

HUNWAR
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100 YARDS NORTH OF WARNER AVENUE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
HUNTINGTON HARBOUR
21CAOCFC 770210 HQ 18070201001 0008.910 OFF
0999 FEET DEPTH

/TYPA/AMBNT/ESTURY

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
39541	PARATHN	MUD	UG/KG	WATER	K	10	1029.500	9935900	3152.100	10000.00	.05	79/05/10	89/01/19
39730	2,4-D	WHL SMPL	UG/L	WATER	K	12	7.337500	198.2200	14.07900	50.000	.050	81/11/12	89/01/19
39731	2,4-D	MUD	UG/KG	BOTTOM	K	1	5000.000			5000.00	5000.00	91/08/13	91/08/13
				WATER	K	8	113.7600	25940.00	161.0600	500.00	.05	81/11/12	89/01/19
39760	SILVEX	WHL SMPL	UG/L	WATER	K	12	11.07600	802.7500	28.33300	100.000	.010	81/11/12	89/01/19
39761	SILVEX	MUD	UG/KG	BOTTOM	K	1	2000.000			2000.00	2000.00	91/08/13	91/08/13
				WATER	K	8	48.75100	2012.400	44.85900	100.00	.01	81/11/12	89/01/19
39780	DICOFOL	WHL SMPL	UG/L	WATER	K	7	.6142900	.2314300	.4810700	1.000	.100	77/07/13	80/10/15
39782	LINDANE	WHL SMPL	UG/L	WATER		1	.0050000			.005	.005	89/01/19	89/01/19
					K	16	1.145000	5.802900	2.408900	10.000	.010	79/05/10	88/01/21
					TOT	17	1.077900	5.516700	2.348800	10.000	.005	79/05/10	89/01/19
39783	LINDANE	MUD DRY	UG/KG	WATER		1	.0050000			.005	.005	89/01/19	89/01/19
					K	12	12.91700	29.35600	5.418100	20.00	5.00	79/05/10	88/01/21
					TOT	13	11.92400	39.73400	6.303500	20.00	.005	79/05/10	89/01/19
71850	NITRATE	TOT-NO3	MG/L	WATER		63	2.606500	11.67600	3.417100	21.0	.1	76/11/22	90/04/12
					K	42	.3838100	.0183860	.1355900	1.0	.1	77/08/10	91/08/13
					TOT	105	1.717400	8.165200	2.857500	21.0	.1	76/11/22	91/08/13
71885	IRON	FE	UG/L	WATER		3	1526.700	5362500	2315.700	4200.00	140.00	77/07/13	86/10/15
71900	MERCURY	HG,TOTAL	UG/L	WATER		7	7.928600	116.4400	10.79100	30.0	.4	77/07/13	83/05/11
					K	14	.8714300	.2022000	.4496700	2.0	.3	78/11/08	89/07/13
					TOT	21	3.223800	46.68400	6.832600	30.0	.3	77/07/13	89/07/13
71921	MERCURY	SEDMG/KG	DRY WGT	WATER		12	.1095800	.0146250	.1209300	.4	.01	78/04/12	85/10/16
					K	7	.2214300	.0313480	.1770500	.4	.02	80/05/14	89/07/13
					TOT	19	.1507900	.0224590	.1498600	.4	.01	78/04/12	89/07/13
74041	WQF	SAMPLE	UPDATED	BOTTOM		1	920110.0			920109	920109	91/08/13	91/08/13
				WATER		175	889700.0	1459E+05	12082.00	920109	860715	85/08/13	91/08/13
78453	PCB-1262	SED DRY	WT UG/KG	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
78828	BZO(GHI)	PERYLENE	SEDUG/KG	BOTTOM	K	1	.2000000			.20	.20	91/08/13	91/08/13
80101	CARBON	DRY WGT	MG/KG	WATER		3	5186.700	22305000	4722.800	10000.0	560.0	83/11/09	85/10/16
81886	PERTHANE	SED DRY	WGTUG/KG	BOTTOM	K	1	7000.000			7000.000	7000.000	91/08/13	91/08/13
				WATER	K	5	94.00100	14680.00	121.1600	300.000	.003	82/11/10	89/01/19
82007	% SAND	IN SED	DRY WGT	WATER		7	69.74300	833.3300	28.86800	92.00	11.20	82/06/03	87/05/21
82008	SEDIMENT	PARTSIZE	SILT	WATER		7	22.51400	760.3200	27.57400	79.60	1.00	82/06/03	87/05/21
82009	SEDIMENT	PARTSIZE	CLAY	WATER		7	6.171400	21.67200	4.655400	13.00	.00	82/06/03	87/05/21

RAINSQ
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AT MAINTENANCE ENCLOSURE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
MILE SQUARE PARK RAIN STA.
21CAOCFC 770817 18070201
0999 FEET DEPTH

/TYPA/AMBNT/STREAM

PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00045 PRECIP TOT DAY IN	WATER		99	.5413100	.3035000	.5509100	3.27	.04	74/12/03	78/04/15
00076 TURB TRBIDMTR HACH FTU	WATER		1	6.900000			6.9	6.9	79/03/27	79/03/27
00095 CNDUCTVY AT 25C MICROMHO	WATER		26	37.01900	1612.700	40.15800	150	4	76/11/11	79/03/27
00403 PH LAB SU	WATER		26	5.571200	.8928300	.9449000	7.7	4.0	76/11/11	79/03/27
00515 RESIDUE DISS-105 C MG/L	WATER		17	14.63000	278.8600	16.69900	63	1	76/11/11	79/03/27
		K	1	1.000000			1	1	79/03/19	79/03/19
		TOT	18	13.87200	272.7700	16.51600	63	1	76/11/11	79/03/27
00610 NH3+NH4- N TOTAL MG/L	WATER		18	.5944500	.8279100	.9098900	3.300	.100	76/11/11	79/03/19
		K	3	.1000000	.0000000	.0000000	.100	.100	78/02/06	79/03/27
		TOT	21	.5238100	.7351500	.8574100	3.300	.100	76/11/11	79/03/27
00625 TOT KJEL N MG/L	WATER		18	2.161100	3.142500	1.772700	6.700	.200	76/11/11	79/03/27
		K	1	.1000000			.100	.100	79/03/19	79/03/19
		TOT	19	2.052600	3.191500	1.786500	6.700	.100	76/11/11	79/03/27
00650 T PO4 PO4 MG/L	WATER		19	.3531600	.0480340	.2191700	.98	.15	76/11/11	79/03/19
		K	6	.0450000	.0002700	.0164320	.06	.03	78/02/06	79/03/27
		TOT	25	.2792000	.0541240	.2326500	.98	.03	76/11/11	79/03/27
00945 SULFATE SO4-TOT MG/L	WATER		13	6.369200	206.8900	14.38400	54	1	77/01/05	79/02/20
		K	9	.7111100	.1886100	.4342900	1	.1	76/11/11	79/03/27
		TOT	22	4.054600	126.4000	11.24300	54	.1	76/11/11	79/03/27
01051 LEAD PB,TOT UG/L	WATER		20	32.30000	695.5900	26.37400	100	5	76/11/11	79/03/27
		K	6	12.00000	48.00000	6.928200	20	2	78/01/03	78/11/13
		TOT	26	27.61500	614.3300	24.78600	100	2	76/11/11	79/03/27
01055 MANGNESE MN UG/L	WATER	K	1	10.00000			10.0	10.0	78/04/06	78/04/06
01092 ZINC ZN,TOT UG/L	WATER		24	36.50000	893.0400	29.88400	124	6	77/01/05	79/03/27
		K	1	10.00000			10	10	79/03/19	79/03/19
		TOT	25	35.44000	883.9300	29.73100	124	6	77/01/05	79/03/27
71850 NITRATE TOT-NO3 MG/L	WATER		20	2.960000	7.693100	2.773600	9.7	.3	77/01/05	79/03/27
		K	6	.5666700	.0666670	.2582000	.9	.4	76/11/11	79/03/19
		TOT	26	2.407700	6.917500	2.630100	9.7	.3	76/11/11	79/03/27
81798 PRECIP/ COMPOSIT INCH/COM	WATER		1	.5300000			.53	.53	76/11/11	76/11/11

EGWC05
33 43 03.0 118 00 51.0 3
AT GOLDEN WEST STREET BRIDGE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
E. GARDEN GROVE WINTERSBURGCHANNEL
21CAOCFC 18070201
0000 FEET DEPTH

/TYPA/AMBNT/STREAM

PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010 WATER TEMP CENT	WATER		193	17.80200	19.72200	4.441000	28.0	7.0	73/04/06	92/02/12
00011 WATER TEMP FAHN	WATER	$	193	64.04100	64.08000	8.005000	82.4	44.6	73/04/06	92/02/12
00060 STREAM FLOW CFS	WATER		71	36.77400	5812.300	76.23800	466	.08	73/04/06	78/03/01
		L	1	.0000000			0	0	77/09/13	77/09/13
		TOT	72	36.26300	5749.200	75.82300	466	0	73/04/06	78/03/01
00061 STREAM FLOW, INST-CFS	WATER		122	50.75800	22267.00	149.2200	1300	.08	73/07/09	92/02/12
		J	30	14.58200	1276.700	35.73100	150	0	73/04/06	87/03/10
		TOT	152	43.61800	18297.00	135.2700	1300	0	73/04/06	92/02/12
00076 TURB TRBIDMTR HACH FTU	WATER		184	22.79300	5250.400	72.45900	860.0	.2	73/05/08	92/03/27
		K	1	.1000000			.1	.1	90/05/22	90/05/22
		TOT	185	22.67100	5224.600	72.28100	860.0	.1	73/05/08	92/03/27
00093 SOLIDS FLOAT MG/L	WATER		4	1195.000	387770.0	622.7100	1920.0	400.0	81/09/14	82/09/20
00094 CNDUCTVY FIELD MICROMHO	WATER		122	1268.000	10475000	3236.500	36000	8	77/01/25	92/02/12
00095 CNDUCTVY AT 25C MICROMHO	WATER		201	1280.200	6179300	2485.800	24000	78	73/04/06	92/03/27
00116 INTNSVE SURVEY IDENT	WATER		64	730600.0	.0000000	.0000000	730601	730601	73/11/17	92/03/27
00300 DO MG/L	WATER		164	8.962700	8.640500	2.939500	15.0	2.0	74/10/08	92/02/12
		L	4	15.00000	.0000000	.0000000	15.0	15.0	76/11/09	84/05/15
		TOT	168	9.106400	9.285800	3.047300	15.0	2.0	74/10/08	92/02/12
00301 DO SATUR PERCENT	WATER	$	166	93.55700	1006.400	31.72400	176.5	21.3	74/10/08	92/02/12
00310 BOD 5 DAY MG/L	WATER		6	8.300000	44.14000	6.643800	20.0	3.0	73/11/17	79/10/09
00335 COD LOWLEVEL MG/L	WATER		43	59.55800	1675.900	40.93800	227.0	11.0	75/07/01	79/10/09
00400 PH SU	WATER		136	7.802100	.4073500	.6382400	10.10	5.60	76/06/02	92/02/12
00403 PH LAB SU	WATER		200	7.789800	.2468600	.4968500	8.8	6.4	73/04/06	92/03/27
00405 CO2 MG/L	WATER		4	4.750000	18.05700	4.249300	10.0	1.1	77/07/12	90/05/22
00440 HCO3 ION HCO3 MG/L	WATER		6	301.1700	10452.00	102.2400	500	221	73/05/08	86/10/13
00445 CO3 ION CO3 MG/L	WATER		3	4.466700	17.85300	4.225300	8	0	73/05/08	77/07/12
00515 RESIDUE DISS-105 C MG/L	WATER		1	280.0000			280	280	90/05/22	90/05/22
00530 RESIDUE TOT NFLT MG/L	WATER		177	130.6900	229620.0	479.1900	5630	.2	73/07/09	92/03/26
		K	20	4.800000	.8000100	.8944300	5	1	79/05/22	92/03/27
		TOT	197	117.9100	207640.0	455.6800	5630	.2	73/07/09	92/03/27
00535 RESIDUE VOL NFLT MG/L	WATER		113	30.92500	8827.800	93.95600	950	.2	74/12/04	92/03/26
		K	30	4.103300	3.341000	1.827900	5	.1	75/02/03	92/03/27
		TOT	143	25.29800	7083.500	84.16400	950	.1	74/12/04	92/03/27
00550 OIL-GRSE TOT-SXLT MG/L	WATER		28	18.66000	5144.600	71.72600	384.0	.6	74/10/29	85/10/15
		K	4	4.000000	4.000000	2.000000	5.0	1.0	75/01/06	86/10/14
		TOT	32	16.82800	4505.400	67.12300	384.0	.6	74/10/29	86/10/14
00610 NH3+NH4- N TOTAL MG/L	WATER		119	.4547900	.3912900	.6255300	4.900	.040	73/06/04	92/03/27
		K	82	.1131700	.0042885	.0654870	.500	.050	73/04/06	92/03/23
		TOT	201	.3154200	.2609200	.5108100	4.900	.040	73/04/06	92/03/27

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PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00612	UN-IONZD	NH3-N	MG/L	WATER	$	135	.0084066	.0002325	.0152480	.093	.000010	73/04/06	91/09/12
00619	UN-IONZD	NH3-NH3	MG/L	WATER	$	135	.0102210	.0003437	.0185400	.113	.00001	73/04/06	91/09/12
00620	NO3-N	TOTAL	MG/L	WATER	K	1	.2000000			.200	.200	90/05/22	90/05/22
00625	TOT KJEL	N	MG/L	WATER		194	2.235800	5.331600	2.309000	28.000	.100	73/05/08	92/03/27
					K	6	.3833300	.0336670	.1834900	.500	.100	79/08/14	92/02/11
					TOT	200	2.180200	5.272000	2.296100	28.000	.100	73/05/08	92/03/27
00650	T PO4	PO4	MG/L	WATER		186	.7726300	.7645000	.8743600	6.61	.01	73/04/06	92/03/27
					K	15	.3220000	.0514460	.2268200	.50	.01	73/10/02	90/06/19
					TOT	201	.7390000	.7248600	.8513900	6.61	.01	73/04/06	92/03/27
00668	PHOS MUD	DRY WGT	MG/KG-P	WATER		8	209.0000	73335.00	270.8000	760.0	.8	80/10/14	86/10/14
00680	T ORG C	C	MG/L	WATER		4	13.61300	21.66700	4.654800	20.5	10.0	83/11/08	86/10/13
00721	CYANIDE	SEDMG/KG	DRY WGT	WATER	K	2	.0300000	.0000000	.0000000	.03	.03	80/10/14	80/10/15
00747	SULFIDE	IN SED.	MG/KG	WATER		1	31.00000			31.00	31.00	82/06/02	82/06/02
					K	6	.7833300	.2656700	.5154300	1.40	.10	80/10/14	85/10/15
					TOT	7	5.100000	130.6600	11.43100	31.00	.10	80/10/14	85/10/15
00900	TOT HARD	CACO3	MG/L	WATER		16	384.6900	954240.0	976.8500	4000	30	73/06/04	92/03/27
00915	CALCIUM	CA,DISS	MG/L	WATER		6	91.50000	1129.500	33.60800	130.0	34.0	73/05/08	86/10/13
00925	MGNSIUM	MG,DISS	MG/L	WATER		7	37.18600	243.3400	15.59900	47.2	3.1	73/05/08	90/05/22
00930	SODIUM	NA,DISS	MG/L	WATER		7	154.1400	2482.500	49.82500	195.00	63.00	73/05/08	90/05/22
00935	PTSSIUM	K,DISS	MG/L	WATER		7	12.85700	59.83300	7.735200	25.00	1.40	73/05/08	90/05/22
00940	CHLORIDE	TOTAL	MG/L	WATER		7	111.4300	2253.600	47.47300	155	13	73/05/08	90/05/22
00945	SULFATE	SO4-TOT	MG/L	WATER		7	264.0000	8739.700	93.48600	359	88	73/05/08	90/05/22
00950	FLUORIDE	F,DISS	MG/L	WATER		7	1.131400	.2310500	.4806800	1.70	.48	73/05/08	90/05/22
00955	SILICA	DISOLVED	MG/L	WATER		119	7.513000	22.70200	4.764700	22.0	.8	73/04/06	90/05/22
					K	2	.4000000	.0200000	.1414200	.5	.3	77/04/12	79/05/09
					TOT	121	7.395400	23.15300	4.811800	22.0	.3	73/04/06	90/05/22
01002	ARSENIC	AS,TOT	UG/L	WATER		8	6.500000	35.42900	5.952200	20	2	76/04/06	84/05/14
					K	12	7.916700	47.53800	6.894800	20	1	75/01/06	87/05/20
					TOT	20	7.350000	41.08200	6.409500	20	1	75/01/06	87/05/20
01003	ARSENIC	SEDMG/KG	DRY WGT	WATER		13	3.923900	28.99900	5.385000	20.00	.80	78/11/07	89/01/18
01020	BORON	B,DISS	UG/L	WATER		7	421.4300	10548.00	102.7000	580	250	73/05/08	90/05/22
01027	CADMIUM	CD,TOT	UG/L	WATER		40	7.417500	264.9200	16.27600	105	.7	73/07/16	85/10/14
					K	23	6.108700	48.54500	6.967400	20	.5	77/07/12	92/03/27
					TOT	63	6.939700	184.2700	13.57500	105	.5	73/07/16	92/03/27
01028	CD MUD	DRY WGT	MG/KG-CD	WATER		9	.3435600	.0489440	.2212300	.80	.13	78/11/07	89/01/18
					K	6	.4766700	.0220270	.1484100	.60	.23	80/05/13	86/10/14
					TOT	15	.3968000	.0403910	.2009800	.80	.13	78/11/07	89/01/18
01029	CHROMIUM	SEDMG/KG	DRY WGT	WATER		15	7.366700	34.42500	5.867300	18.00	1.70	78/11/07	89/01/18
01034	CHROMIUM	CR,TOT	UG/L	WATER		46	13.87000	243.9800	15.62000	67	2	75/01/06	92/02/09

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01034 CHROMIUM CR,TOT UG/L	WATER	K	49	8.295900	82.29100	9.071400	50	1	76/12/07	92/03/27
01034 CHROMIUM CR,TOT UG/L	WATER	TOT	95	10.99500	166.6600	12.91000	67	1	75/01/06	92/03/27
01042 COPPER CU,TOT UG/L	WATER		111	18.89600	223.8700	14.96200	103	2	73/07/16	92/03/27
		K	21	11.33300	32.43300	5.695000	20	3	77/03/31	92/03/23
		TOT	132	17.69300	200.6400	14.16500	103	2	73/07/16	92/03/27
01043 COPPER SEDMG/KG DRY WGT	WATER		15	148.5000	262750.0	512.5900	2000.00	2.20	78/11/07	89/01/18
01045 IRON FE,TOT UG/L	WATER		2	990.0000	480200.0	692.9700	1480	500	83/11/07	85/10/14
01051 LEAD PB,TOT UG/L	WATER		123	87.47200	15780.00	125.6200	800	3	73/11/05	92/03/27
		K	40	14.67500	229.9700	15.16500	70	2	73/07/16	92/03/23
		TOT	163	69.60700	12926.00	113.6900	800	2	73/07/16	92/03/27
01052 LEAD SEDMG/KG DRY WGT	WATER		14	25.43600	157.7600	12.56000	42.00	4.30	78/11/07	86/10/14
01053 MN MUD DRY WGT MG/KG-MN	WATER		1	42.00000			42.00	42.00	79/05/09	79/05/09
01067 NICKEL NI,TOTAL UG/L	WATER		1	10.00000			10	10	92/02/09	92/02/09
		K	9	20.00000	225.0000	15.00000	40	10	92/02/09	92/03/27
		TOT	10	19.00000	210.0000	14.49100	40	10	92/02/09	92/03/27
01077 SILVER AG,TOT UG/L	WATER		1	4.000000			4.0	4.0	92/02/09	92/02/09
		K	9	4.666700	16.00000	4.000000	10.0	2.0	92/02/09	92/03/27
		TOT	10	4.600000	14.26700	3.777100	10.0	2.0	92/02/09	92/03/27
01092 ZINC ZN,TOT UG/L	WATER		131	73.09900	7078.000	84.13100	580	8	75/01/06	92/03/26
		K	14	16.85700	64.74800	8.046600	25	2	73/07/16	92/03/27
		TOT	145	67.66900	6673.500	81.69200	580	2	73/07/16	92/03/27
01093 ZINC SEDMG/KG DRY WGT	WATER		15	39.92000	219.3300	14.81000	71.00	10.80	78/11/07	89/01/18
01143 SILICON SILICATE UG/L SI	WATER	K	1	.1000000			.1	.1	83/05/09	83/05/09
01147 SELENIUM SE,TOT UG/L	WATER		6	5.466700	30.18700	5.494300	16	1	75/01/06	81/05/19
		K	14	9.214300	54.95100	7.412900	20	1	77/07/12	87/05/20
		TOT	20	8.090000	48.64600	6.974700	20	1	75/01/06	87/05/20
01148 SELENIUM SEDMG/KG DRY WGT	WATER		2	.0895000	.0008405	.0289910	.11	.07	80/05/13	81/05/19
		K	11	.5100000	.2134400	.4620000	1.50	.05	78/11/07	86/10/14
		TOT	13	.4453100	.2028700	.4504200	1.50	.05	78/11/07	86/10/14
01170 FE MUD DRY WGT MG/KG-FE	WATER		3	3400.000	210000.0	458.2600	3900.00	3000.00	83/11/08	86/10/14
31507 TOT COLI MPN COMP /100ML	WATER		101	131730.0	1787E+08	422760.0	2400000	240	74/12/04	82/09/21
		K	1	200.0000			200	200	80/04/08	80/04/08
		L	4	2400000	.0000000	.0000000	2400000	2400000	78/11/22	81/10/02
		TOT	106	216090.0	3591E+08	599330.0	2400000	200	74/12/04	82/09/21
31615 FEC COLI MPNECMED /100ML	WATER		3	1643.300	1126600	1061.400	2400	430	75/10/07	77/10/11
31677 FECSTREP MPNADEVA /100ML	WATER		1	2300.000			2300	2300	75/10/07	75/10/07
32730 PHENOLS TOTAL UG/L	WATER	K	12	35.83300	317.4300	17.81700	50	10	77/01/25	82/11/09
32860 INVALID PAR NUMBER	WATER		1	.2500000			.2500000	.2500000	78/04/11	78/04/11
34257 BETA BHC SEDUG/KG DRY WGT	WATER	K	5	31.00000	1530.000	39.11500	100.000	5.000	82/11/09	86/10/14

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34259	DELTABHC TOTUG/L	WATER	K	5	2.032000	19.84100	4.454300	10.000	.010	82/11/09	86/10/14
34262	DELTABHC SEDUG/KG DRY WGT	WATER	K	5	31.00000	1530.000	39.11500	100.000	5.000	82/11/09	86/10/14
34337	DIETHYLP HTHALATE DISSUG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
34338	DIETHYLP HTHALATE SUSPUG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
34351	ENDSULSF TOTUG/L	WATER	K	5	2.070000	19.65200	4.433100	10.000	.050	82/11/09	86/10/14
34354	ENDSULSF SEDUG/KG DRY WGT	WATER	K	5	84.00000	14830.00	121.7800	300.000	10.000	82/11/09	86/10/14
34356	B-ENDO SULFAN TOTWUG/L	WATER	K	5	2.032000	19.84100	4.454300	10.000	.010	82/11/09	86/10/14
34359	BENDOSUL SEDUG/KG DRY WGT	WATER	K	5	31.00000	1530.000	39.11500	100.000	5.000	82/11/09	86/10/14
34361	A-ENDO SULFAN TOTWUG/L	WATER	K	5	2.032000	19.84100	4.454300	10.000	.010	82/11/09	86/10/14
34364	AENDOSUL SEDUG/KG DRY WGT	WATER	K	5	31.00000	1530.000	39.11500	100.000	5.000	82/11/09	86/10/14
34671	PCB 1016 TOTWUG/L	WATER	K	7	.9000000	.0700000	.2645800	1.000	.300	81/11/10	86/10/14
38260	MBAS MG/L	WATER		9	.1688900	.0205610	.1433900	.43	.04	74/10/08	85/10/15
			K	8	.0662500	.0021697	.0465800	.10	.01	74/12/04	86/10/14
			TOT	17	.1205900	.0140180	.1184000	.43	.01	74/10/08	86/10/14
39034	PERTHANE WHL SMPL UG/L	WATER	K	10	1.850000	8.225000	2.867900	10.000	.500	79/05/09	86/10/14
39046	SIMAZINE MUD UG/GK	WATER	K	6	19.16700	264.1700	16.25300	50.00	5.00	79/05/09	86/10/14
39055	SIMAZINE WH.WATER (UG/L)	WATER	K	6	.9166700	.0416670	.2041300	1	.5	79/05/09	86/10/14
39076	ALPHABHC SEDUG/KG DRY WGT	WATER	K	4	32.50000	2075.000	45.55200	100.000	5.000	83/11/08	86/10/14
39330	ALDRIN TOT UG/L	WATER	K	17	.5562900	.2360400	.4858400	1.000	.002	75/07/01	86/10/14
39333	ALDRIN SEDUG/KG DRY WGT	WATER	K	13	19.65400	637.8100	25.25500	100.00	.50	78/11/07	86/10/14
39337	ALPHABHC TOTUG/L	WATER	K	4	.0387500	.0005062	.0225000	.050	.005	83/11/08	86/10/14
39338	BETA BHC TOTUG/L	WATER	K	4	.0400000	.0004000	.0200000	.050	.010	83/11/08	86/10/14
39340	GAMMABHC LINDANE TOT.UG/L	WATER	K	14	.6007200	.2294700	.4790300	1.000	.010	75/07/01	84/05/15
39343	GBHC-MUD LINDANE DRYUG/KG	WATER	K	11	13.68200	59.11400	7.688600	20.00	.50	78/11/07	84/05/15
39346	METOLACH TISSUES MG/KG	WATER	K	1	1.000000			1.000	1.000	79/05/09	79/05/09
39350	CHLRDANE TECH&MET TOT UG/L	WATER	K	17	.6062400	.1913900	.4374800	1.000	.006	75/07/01	86/10/14
39351	CDANEDRY TECH&MET MUDUG/KG	WATER	K	13	62.73100	17964.00	134.0300	500.00	.50	78/11/07	86/10/14
39360	DDD WHL SMPL UG/L	WATER	K	16	.5289400	.2374200	.4872500	1.000	.003	75/07/01	86/10/14
39363	DDD MUD UG/KG	WATER	K	13	20.03900	627.5200	25.05000	100.00	.50	78/11/07	86/10/14
39365	DDE WHL SMPL UG/L	WATER	K	16	.5288800	.2374900	.4873200	1.000	.002	75/07/01	86/10/14
39368	DDE MUD UG/KG	WATER	K	13	20.03900	627.5200	25.05000	100.00	.50	78/11/07	86/10/14
39370	DDT WHL SMPL UG/L	WATER	K	17	.5660600	.2258300	.4752100	1.000	.003	75/07/01	86/10/14
39373	DDT MUD UG/KG	WATER	K	13	38.11500	6286.600	79.28800	300.00	.50	78/11/07	86/10/14
39380	DIELDRIN TOTUG/L	WATER	K	17	.5565900	.2357000	.4854900	1.000	.002	75/07/01	86/10/14
39381	DIELDRIN DISUG/L	WATER	K	1	20.00000			20.000	20.000	80/05/13	80/05/13
39383	DIELDRIN SEDUG/KG DRY WGT	WATER	K	13	20.03900	627.5200	25.05000	100.00	.50	78/11/07	86/10/14
39390	ENDRIN TOT UG/L	WATER	K	17	.5656500	.2263100	.4757200	1.000	.006	75/07/01	86/10/14
39393	ENDRIN SEDUG/KG DRY WGT	WATER	K	13	29.65400	2716.200	52.11700	200.00	.50	78/11/07	86/10/14
39400	TOXAPHEN TOTUG/L	WATER	K	17	.8117700	.1298500	.3603500	1.000	.100	75/07/01	86/10/14

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39403	TOXAPHEN SEDUG/KG	DRY WGT	WATER	K	12	317.9600	732630.0	855.9400	3000.00	.50	78/11/07	86/10/14
39410	HEPTCHLR	TOTUG/L	WATER	K	17	.5565900	.2357000	.4854900	1.000	.002	75/07/01	86/10/14
39413	HEPTCHLR SEDUG/KG	DRY WGT	WATER	K	13	20.03900	627.5200	25.05000	100.00	.50	78/11/07	86/10/14
39420	HPCHLREP	TOTUG/L	WATER	K	17	.5565900	.2357000	.4854900	1.000	.002	75/07/01	86/10/14
39423	HPCHLREP SEDUG/KG	DRY WGT	WATER	K	13	20.03900	627.5200	25.05000	100.00	.50	78/11/07	86/10/14
39480	MTHXYCLR WHL SMPL	UG/L	WATER	K	14	.7792900	.1360100	.3687900	1.000	.010	75/07/01	86/10/14
39481	MTHXYCLR MUD DRY	UG/KG	WATER	K	10	70.00000	23045.00	151.8000	500.00	10.00	79/10/09	86/10/14
39488	PCB-1221	TOTUG/L	WATER	K	7	.9000000	.0700000	.2645800	1.000	.300	81/11/10	86/10/14
39491	PCB-1221 SEDUG/KG	DRY WGT	WATER	K	6	590.0000	1404400	1185.100	3000.00	20.00	81/11/10	86/10/14
39492	PCB-1232	TOTUG/L	WATER	K	15	.9533300	.0326670	.1807400	1.000	.300	77/01/25	86/10/14
39495	PCB-1232 SEDUG/KG	DRY WGT	WATER	K	13	278.8900	675100.0	821.6400	3000.00	.50	78/11/07	86/10/14
39496	PCB-1242	TOTUG/L	WATER	K	15	.9533300	.0326670	.1807400	1.000	.300	77/01/25	86/10/14
39499	PCB-1242 SEDUG/KG	DRY WGT	WATER	K	13	278.8900	675100.0	821.6400	3000.00	.50	78/11/07	86/10/14
39500	PCB-1248	TOTUG/L	WATER	K	7	.9000000	.0700000	.2645800	1.000	.300	81/11/10	86/10/14
39503	PCB-1248 SEDUG/KG	DRY WGT	WATER	K	5	704.0000	1658100	1287.700	3000.00	20.00	82/06/02	86/10/14
39504	PCB-1254	TOTUG/L	WATER	K	15	.9533300	.0326670	.1807400	1.000	.300	77/01/25	86/10/14
39507	PCB-1254 SEDUG/KG	DRY WGT	WATER	K	13	278.8900	675100.0	821.6400	3000.00	.50	78/11/07	86/10/14
39508	PCB-1260	TOTUG/L	WATER	K	15	.9533300	.0326670	.1807400	1.000	.300	77/01/25	86/10/14
39511	PCB-1260 SEDUG/KG	DRY WGT	WATER	K	13	278.8900	675100.0	821.6400	3000.00	.50	78/11/07	86/10/14
39514	PCB-1016 SEDUG/KG	DRY WGT	WATER	K	5	704.0000	1658100	1287.700	3000.00	20.00	81/11/10	86/10/14
39530	MALATHN WHL SMPL	UG/L	WATER	K	11	1.647300	7.816200	2.795800	10.000	.020	75/07/01	86/10/14
39531	MALATHN MUD	UG/KG	WATER	K	10	130.5000	94614.00	307.5900	1000.00	5.00	79/05/09	86/10/14
39540	PARATHN WHL SMPL	UG/L	WATER	K	10	1.802000	8.392100	2.896900	10.000	.020	75/07/01	86/10/14
39541	PARATHN MUD	UG/KG	WATER	K	10	130.5000	94614.00	307.5900	1000.00	5.00	79/05/09	86/10/14
39730	2,4-D WHL SMPL	UG/L	WATER	K	8	4.687500	21.56700	4.644000	10.000	.500	79/05/09	86/10/14
39731	2,4-D MUD	UG/KG	WATER	K	7	150.7200	27254.00	165.0900	500.00	5.00	81/11/10	86/10/14
39760	SILVEX WHL SMPL	UG/L	WATER	K	7	4.471400	26.84600	5.181300	10.000	.100	81/11/10	86/10/14
39761	SILVEX MUD	UG/KG	WATER	K	7	64.42900	2107.300	45.90500	100.00	1.00	81/11/10	86/10/14
39780	DICOFOL WHL SMPL	UG/L	WATER	K	8	.5381300	.2447700	.4947400	1.000	.005	75/07/01	80/10/14
39782	LINDANE WHL SMPL	UG/L	WATER	K	14	.6547900	.2311700	.4808000	1.000	.007	75/07/01	86/10/14
39783	LINDANE MUD DRY	UG/KG	WATER	K	12	21.66700	646.9700	25.43600	100.00	5.00	79/05/09	86/10/14
46570	CAL HARD CA MG	MG/L	WATER	$	6	405.0000	6172.300	78.56400	506	270	73/05/08	86/10/13
70301	DISS SOL SUM	MG/L	WATER		6	944.3300	14793.00	121.6300	1100	780	73/05/08	86/10/13
71850	NITRATE TOT-NO3	MG/L	WATER		181	16.31800	313.7900	17.71400	141.0	.08	73/04/06	92/03/27
				K	20	.7995000	1.551800	1.245700	4.4	.02	76/08/31	90/06/19
				TOT	201	14.77400	304.2400	17.44300	141.0	.02	73/04/06	92/03/27
71885	IRON FE	UG/L	WATER		6	560.0000	109080.0	330.2700	970.00	120.00	75/01/06	84/05/14
71900	MERCURY HG,TOTAL	UG/L	WATER		6	5.833300	22.60300	4.754200	13.7	1.0	78/04/11	82/06/01
				K	11	2.945500	34.15900	5.844600	20.0	.2	75/07/01	86/10/13

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AT GOLDEN WEST STREET BRIDGE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
E. GARDEN GROVE WINTERSBURGCHANNEL
21CAOCFC 18070201
0000 FEET DEPTH

/TYPA/AMBNT/STREAM

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
71900 MERCURY	HG,TOTAL	UG/L		WATER	TOT	17	3.964700	30.43600	5.516900	20.0	.2	75/07/01	86/10/13
71921 MERCURY	SEDMG/KG	DRY WGT		WATER		6	.0725000	.0038179	.0617890	.2	.01	78/11/07	82/06/02
					K	9	.1933300	.0221250	.1487500	.5	.01	80/10/14	89/01/18
					TOT	15	.1450000	.0177610	.1332700	.5	.01	78/11/07	89/01/18
74041 WQF	SAMPLE	UPDATED		WATER		71	896250.0	3484E+05	18668.00	920708	860715	79/05/22	92/03/27
80101 CARBON	DRY WGT	MG/KG		WATER		3	869.3300	457220.0	676.1800	1400.0	108.0	83/11/08	86/10/14
81799 AVG.STRM	FLOW PER	COMP.CFS		WATER		13	9.765400	802.1600	28.32300	104	1	79/06/11	82/01/11
81886 PERTHANE	SED DRY	WGTUG/KG		WATER	K	6	125.0000	35430.00	188.2300	500.000	10.000	81/11/10	86/10/14
82007 % SAND	IN SED	DRY WGT		WATER		5	80.24000	1535.700	39.18800	99.00	10.20	82/06/02	85/10/15
82008 SEDIMENT	PARTSIZE	SILT		WATER		4	21.10000	1575.100	39.68700	80.60	.00	82/06/02	84/05/15
					K	1	1.000000			1.00	1.00	85/10/15	85/10/15
					TOT	5	17.08000	1262.100	35.52600	80.60	.00	82/06/02	85/10/15
82009 SEDIMENT	PARTSIZE	CLAY		WATER		4	3.350000	15.93000	3.991300	9.20	.20	82/06/02	84/05/15
					K	1	1.000000			1.00	1.00	85/10/15	85/10/15
					TOT	5	2.880000	13.05200	3.612800	9.20	.20	82/06/02	85/10/15
82028 RATIO	FEC COL	FEC STRP		WATER	$	1	.1869600			.2	.2	75/10/07	75/10/07

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CIRCULAR BAY N/O SHARKFIN AND MARINABAY INT.
06059 CALIFORNIA ORANGE
CALIFORNIA 140700
SANTA ANA RIVER BASIN HUNTINGTON HARBOR
21CAOCFC 800927
0000 FEET DEPTH

/TYPA/AMBNT/ESTURY

PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010 WATER TEMP CENT	WATER		306	19.65200	9.529100	3.086900	26.6	12.5	79/10/10	90/05/23
00011 WATER TEMP FAHN	WATER	$	306	67.37300	30.92800	5.561300	79.9	54.5	79/10/10	90/05/23
00035 WIND VELOCITY MPH	WATER		35	3.371400	4.299200	2.073500	10.0	.0	82/07/07	88/06/16
00036 WIND DIR.FROM NORTH-0	WATER		31	205.7400	3762.800	61.34100	300	23	82/07/07	88/06/16
00065 STREAM STAGE FEET	WATER		36	2.785000	2.518700	1.587100	5.80	.10	82/07/07	88/04/28
00067 TIDE STAGE CODE	WATER		35	3864.300	5640100	2374.900	7610	1010	82/07/07	88/04/28
00076 TURB TRBIDMTR HACH FTU	WATER		4	1.450000	5.301300	2.302500	4.9	.2	87/05/21	90/06/21
00078 TRANSP SECCHI METERS	WATER		29	1.767300	.2000500	.4472700	2.50	1.00	84/08/22	88/06/16
00094 CNDUCTVY FIELD MICROMHO	WATER		289	49234.00	11997000	3463.600	57500	28700	79/10/10	90/05/23
00095 CNDUCTVY AT 25C MICROMHO	WATER		4	49750.00	1582400	1258.000	51000	48000	87/05/21	90/06/21
00300 DO MG/L	WATER		292	6.946100	2.385200	1.544400	10.7	1.7	79/10/10	90/05/23
00301 DO SATUR PERCENT	WATER	$	290	74.95100	304.5100	17.45000	120.7	19.6	79/10/10	90/05/23
00400 PH SU	WATER		294	7.954100	.1563600	.3954200	9.30	6.40	79/10/10	90/05/23
00403 PH LAB SU	WATER		4	7.900000	.0801190	.2830500	8.1	7.5	87/05/21	90/06/21
00530 RESIDUE TOT NFLT MG/L	WATER		2	16.00000	18.00000	4.242600	19	13	87/05/21	90/06/21
		K	2	5.000000	.0000000	.0000000	5	5	88/05/12	88/10/14
		TOT	4	10.50000	46.33300	6.806900	19	5	87/05/21	90/06/21
00535 RESIDUE VOL NFLT MG/L	WATER		2	8.500000	.5000000	.7071100	9	8	87/05/21	90/06/21
		K	2	5.000000	.0000000	.0000000	5	5	88/05/12	88/10/14
		TOT	4	6.750000	4.250000	2.061600	9	5	87/05/21	90/06/21
00610 NH3+NH4- N TOTAL MG/L	WATER		4	.3000000	.0266670	.1633000	.500	.100	87/05/21	90/06/21
00625 TOT KJEL N MG/L	WATER		4	.6750000	.0291670	.1707800	.900	.500	87/05/21	90/06/21
00650 T PO4 PO4 MG/L	WATER		2	.3500000	.0049999	.0707100	.40	.30	87/05/21	90/06/21
		K	2	.5000000	.0000000	.0000000	.50	.50	88/05/12	88/10/14
		TOT	4	.4250000	.0091667	.0957430	.50	.30	87/05/21	90/06/21
00745 SULFIDE TOTAL MG/L	WATER		1	.0000000			.00	.00	84/09/26	84/09/26
01002 ARSENIC AS,TOT UG/L	WATER	K	1	4.000000			4	4	87/05/21	87/05/21
01027 CADMIUM CD,TOT UG/L	WATER	K	1	1.000000			1	1	88/10/14	88/10/14
01034 CHROMIUM CR,TOT UG/L	WATER	K	3	17.33300	386.3300	19.65500	40	5	87/05/21	90/06/21
01042 COPPER CU,TOT UG/L	WATER		3	42.00000	1372.000	37.04100	80	6	87/05/21	90/06/21
		K	1	20.00000			20	20	88/05/12	88/05/12
		TOT	4	36.50000	1035.700	32.18200	80	6	87/05/21	90/06/21
01051 LEAD PB,TOT UG/L	WATER	K	4	54.00000	9485.300	97.39300	200	2	87/05/21	90/06/21
01092 ZINC ZN,TOT UG/L	WATER		1	30.00000			30	30	88/10/14	88/10/14
		K	2	25.00000	50.00000	7.071100	30	20	88/05/12	90/06/21
		TOT	3	26.66700	33.33400	5.773600	30	20	88/05/12	90/06/21
01147 SELENIUM SE,TOT UG/L	WATER	K	1	1.000000			1	1	87/05/21	87/05/21
71850 NITRATE TOT-NO3 MG/L	WATER	K	4	.3500000	.0100000	.1000000	.4	.2	87/05/21	90/06/21
74041 WQF SAMPLE UPDATED	WATER		176	888570.0	1089E+05	10436.00	900821	860715	85/10/16	90/06/21

MSPLA1
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SOUTH SIDE OF PHASE ONE LAKE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
MILE SQUARE PARK
21CAOCFC 770210 18070201
0999 FEET DEPTH

/TYPA/AMBNT/LAKE

	PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER TEMP CENT	WATER		215	20.84600	21.08800	4.592200	30.2	10.0	76/11/11	90/04/03
00011	WATER TEMP FAHN	WATER	$	215	69.52200	68.52100	8.277700	86.4	50.0	76/11/11	90/04/03
00076	TURB TRBIDMTR HACH FTU	WATER		70	4.817000	78.83800	8.879100	72.0	.4	76/11/11	88/07/18
00078	TRANSP SECCHI METERS	WATER		10	.9470000	.2242000	.4735000	2.00	.22	84/12/13	88/09/27
00094	CNDUCTVY FIELD MICROMHO	WATER		167	660.1700	57938.00	240.7000	1800	320	77/01/26	90/04/03
00095	CNDUCTVY AT 25C MICROMHO	WATER		70	640.8600	11238.00	106.0100	1050	450	76/11/11	88/07/18
00300	DO MG/L	WATER		192	11.56600	8.069800	2.840700	19.2	1.3	76/11/11	90/04/03
			L	22	15.00000	.0000000	.0000000	15.0	15.0	76/12/14	88/07/06
			TOT	214	11.91900	8.329400	2.886100	19.2	1.3	76/11/11	90/04/03
00301	DO SATUR PERCENT	WATER	$	211	132.2200	1241.200	35.23000	234.2	14.5	76/11/11	90/04/03
00335	COD LOWLEVEL MG/L	WATER		17	43.72900	700.8700	26.47400	120.0	12.0	77/06/07	79/10/24
			K	1	1.000000			1.0	1.0	78/04/18	78/04/18
			TOT	18	41.35600	761.0800	27.58800	120.0	1.0	77/06/07	79/10/24
00400	PH SU	WATER		166	8.304300	.3706000	.6087700	10.50	5.80	76/11/11	90/04/03
			J	1	7.000000			7.00	7.00	88/11/17	88/11/17
			TOT	167	8.296400	.3785300	.6152500	10.50	5.80	76/11/11	90/04/03
00403	PH LAB SU	WATER		70	7.927800	.2707200	.5203100	9.4	6.7	76/11/11	88/07/18
00405	CO2 MG/L	WATER		18	8.344500	40.99800	6.403000	21.0	.0	76/11/11	86/10/16
00440	HCO3 ION HCO3 MG/L	WATER		16	176.1900	2002.800	44.75300	287	120	76/11/11	86/10/16
00445	CO3 ION CO3 MG/L	WATER		2	.0000000	.0000000	.0000000	0	0	85/11/19	86/10/16
00515	RESIDUE DISS-105 C MG/L	WATER		1	395.0000			395	395	86/10/16	86/10/16
00530	RESIDUE TOT NFLT MG/L	WATER		62	22.20000	388.0100	19.69800	92	.8	76/11/11	88/07/18
			K	4	4.000000	4.000000	2.000000	5	1	86/03/31	88/05/09
			TOT	66	21.09700	383.4700	19.58200	92	.8	76/11/11	88/07/18
00535	RESIDUE VOL NFLT MG/L	WATER		56	14.91800	195.8000	13.99300	59	.4	77/05/10	88/07/18
			K	6	2.833300	5.666700	2.380500	5	.5	80/10/14	88/05/09
			TOT	62	13.74800	189.9800	13.78300	59	.4	77/05/10	88/07/18
00610	NH3+NH4- N TOTAL MG/L	WATER		46	.4260900	.1556600	.3945400	2.000	.020	76/11/11	88/05/09
			K	21	.1381000	.0144760	.1203200	.500	.100	76/12/14	88/07/18
			TOT	67	.3358200	.1286400	.3586600	2.000	.020	76/11/11	88/07/18
00612	UN-IONZD NH3-N MG/L	WATER	$	60	.0322430	.0029620	.0544250	.349	.000008	76/11/11	86/10/16
00619	UN-IONZD NH3-NH3 MG/L	WATER	$	60	.0392040	.0043791	.0661750	.424	.000009	76/11/11	86/10/16
00625	TOT KJEL N MG/L	WATER		67	1.571300	1.006400	1.003200	5.800	.150	76/11/11	89/06/20
			K	2	.3500000	.0450000	.2121300	.500	.200	79/10/24	83/08/31
			TOT	69	1.535900	1.020100	1.010000	5.800	.150	76/11/11	89/06/20
00650	T PO4 PO4 MG/L	WATER		58	.2877600	.0593650	.2436500	1.30	.03	76/11/11	88/01/25
			K	10	.1810000	.0302770	.1740000	.50	.01	79/11/28	88/07/18
			TOT	68	.2720600	.0560230	.2366900	1.30	.01	76/11/11	88/07/18
00668	PHOS MUD DRY WGT MG/KG-P	WATER		4	653.5000	499110.0	706.4800	1600.0	15.0	83/05/12	85/11/19

MSPLA1
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SOUTH SIDE OF PHASE ONE LAKE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
/TYPA/AMBNT/LAKE MILE SQUARE PARK
21CAOCFC 770210 18070201
0999 FEET DEPTH

PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00668 PHOS MUD DRY WGT MG/KG-P	WATER	K	1	10.00000			10.0	10.0	83/11/10	83/11/10
00668 PHOS MUD DRY WGT MG/KG-P	WATER	TOT	5	524.8000	457150.0	676.1300	1600.0	10.0	83/05/12	85/11/19
00680 T ORG C C MG/L	WATER		3	8.133300	17.05300	4.129600	11.0	3.4	83/08/19	86/10/16
		K	3	3.000000	.0000000	.0000000	3.0	3.0	84/05/10	85/11/19
		TOT	6	5.566700	14.72700	3.837500	11.0	3.0	83/08/19	86/10/16
00747 SULFIDE IN SED. MG/KG	WATER		2	56.00000	242.0000	15.55600	67.00	45.00	83/05/12	83/11/10
		K	3	1.000000	.0000000	.0000000	1.00	1.00	83/11/07	85/11/19
		TOT	5	23.00000	968.0000	31.11300	67.00	1.00	83/05/12	85/11/19
00900 TOT HARD CACO3 MG/L	WATER		16	213.5600	3179.900	56.39000	346	60	76/11/11	86/10/16
00915 CALCIUM CA,DISS MG/L	WATER		16	64.03100	418.2800	20.45200	120.0	42.0	76/11/11	86/10/16
00925 MGNSIUM MG,DISS MG/L	WATER		16	16.83800	7.768000	2.787100	24.5	10.0	76/11/11	86/10/16
00930 SODIUM NA,DISS MG/L	WATER		16	46.87500	288.1200	16.97400	106.00	21.00	76/11/11	86/10/16
00935 PTSSIUM K,DISS MG/L	WATER		16	4.050000	1.401400	1.183800	7.70	2.90	76/11/11	86/10/16
00940 CHLORIDE TOTAL MG/L	WATER		16	61.18800	449.9000	21.21100	132	49	76/11/11	86/10/16
00945 SULFATE SO4-TOT MG/L	WATER		16	90.03100	273.8200	16.54800	114	39	76/11/11	86/10/16
00950 FLUORIDE F,DISS MG/L	WATER		16	.5706300	.0640200	.2530200	1.40	.39	76/11/11	86/10/16
00955 SILICA DISOLVED MG/L	WATER		44	17.11800	59.67200	7.724800	35.8	4.3	76/11/11	86/10/16
01002 ARSENIC AS,TOT UG/L	WATER		2	2.500000	.5000000	.7071100	3	2	80/10/14	81/05/19
01020 BORON B,DISS UG/L	WATER		14	244.2900	24119.00	155.3000	730	90	76/11/11	86/10/16
		K	2	55.00000	4050.000	63.64000	100	10	77/02/08	85/11/19
		TOT	16	220.6300	25353.00	159.2300	730	10	76/11/11	86/10/16
01027 CADMIUM CD,TOT UG/L	WATER		3	3.666700	2.333400	1.527500	5	2	77/06/07	81/05/19
		K	2	3.000000	8.000000	2.828400	5	1	77/08/09	80/10/14
		TOT	5	3.400000	3.300000	1.816600	5	1	77/06/07	81/05/19
01029 CHROMIUM SEDMG/KG DRY WGT	WATER		1	2.900000			2.90	2.90	83/08/19	83/08/19
01034 CHROMIUM CR,TOT UG/L	WATER		2	12.50000	112.5000	10.60700	20	5	77/06/07	81/05/19
		K	8	4.250000	1.357200	1.165000	5	2	77/08/09	88/04/11
		TOT	10	5.900000	25.65600	5.065100	20	2	77/06/07	88/04/11
01042 COPPER CU,TOT UG/L	WATER		11	9.090900	45.89100	6.774300	24	3	76/11/11	86/10/16
		K	11	6.090900	12.69100	3.562400	12	1	77/09/13	88/04/11
		TOT	22	7.590900	30.25300	5.500300	24	1	76/11/11	88/04/11
01043 COPPER SEDMG/KG DRY WGT	WATER		6	7.916700	24.82200	4.982100	17.00	3.20	83/05/12	85/11/19
01051 LEAD PB,TOT UG/L	WATER		6	33.16700	710.5700	26.65700	80	14	77/06/07	80/10/14
		K	8	9.000000	46.00000	6.782300	24	5	77/08/09	88/04/11
		TOT	14	19.35700	452.0900	21.26300	80	5	77/06/07	88/04/11
01052 LEAD SEDMG/KG DRY WGT	WATER		1	2.100000			2.10	2.10	83/08/19	83/08/19
01055 MANGNESE MN UG/L	WATER	K	1	10.00000			10.0	10.0	77/10/11	77/10/11
01092 ZINC ZN,TOT UG/L	WATER		5	20.60000	466.8000	21.60600	57	6	77/06/07	88/04/11
		K	5	11.00000	72.00000	8.485300	20	2	83/08/19	88/01/25

MSPLA1
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SOUTH SIDE OF PHASE ONE LAKE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
MILE SQUARE PARK
21CAOCFC 770210 18070201
0999 FEET DEPTH

/TYPA/AMBNT/LAKE

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
01092	ZINC	ZN,TOT	UG/L	WATER	TOT	10	15.80000	265.0700	16.28100	57	2	77/06/07	88/04/11
01093	ZINC	SEDMG/KG	DRY WGT	WATER		1	15.00000			15.00	15.00	83/08/19	83/08/19
01147	SELENIUM	SE,TOT	UG/L	WATER		1	13.00000			13	13	81/05/19	81/05/19
					K	1	2.000000			2	2	80/10/14	80/10/14
					TOT	2	7.500000	60.50000	7.778200	13	2	80/10/14	81/05/19
32730	PHENOLS	TOTAL	UG/L	WATER	K	1	50.00000			50	50	77/07/12	77/07/12
46570	CAL HARD	CA MG	MG/L	WATER	$	16	229.2200	3149.900	56.12400	366	166	76/11/11	86/10/16
70301	DISS SOL	SUM	MG/L	WATER		15	407.8000	7417.700	86.12600	707	358	76/11/11	85/11/19
71850	NITRATE	TOT-NO3	MG/L	WATER		58	3.752400	8.915200	2.985800	17.0	.2	76/11/11	88/05/09
					K	10	.7130000	1.725700	1.313700	4.4	.1	78/05/09	88/07/18
					TOT	68	3.305400	8.992400	2.998700	17.0	.1	76/11/11	88/07/18
71885	IRON	FE	UG/L	WATER		1	60.00000			60.00	60.00	77/10/11	77/10/11
71900	MERCURY	HG,TOTAL	UG/L	WATER	K	2	2.000000	2.000000	1.414200	3.0	1.0	80/10/14	81/05/19
74041	WQF	SAMPLE	UPDATED	WATER		108	883540.0	1691E+05	13007.00	900412	860717	85/11/19	90/04/03
80101	CARBON	DRY WGT	MG/KG	WATER		5	2436.000	2447700	1564.500	4000.0	240.0	83/11/10	86/10/16
81613	SULFIDES	SEDIMENT	MG/G	WATER	K	1	.0010000			.001	.001	84/11/07	84/11/07
82007	% SAND	IN SED	DRY WGT	WATER		1	87.00000			87.00	87.00	84/05/10	84/05/10
82008	SEDIMENT	PARTSIZE	SILT	WATER		1	8.000000			8.00	8.00	84/05/10	84/05/10
82009	SEDIMENT	PARTSIZE	CLAY	WATER		1	5.000000			5.00	5.00	84/05/10	84/05/10

HUNCRUST HUNCST
33 43 07.0 118 04 10.0 4
AT BROADWAY ST. BRIDGE
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21CAOCFC 801101
0000 FEET DEPTH

/TYPA/AMBNT/ESTURY

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER		218	19.57600	12.18100	3.490100	26.4	1.8	79/10/10	90/05/23
00011	WATER	TEMP	FAHN	WATER	$	218	67.23600	39.64100	6.296100	79.5	35.3	79/10/10	90/05/23
00035	WIND	VELOCITY	MPH	WATER		31	1.283900	2.841400	1.685700	7.8	.0	82/07/07	88/06/16
					K	1	2.000000			2.0	2.0	87/08/20	87/08/20
					TOT	32	1.306300	2.765800	1.663100	7.8	.0	82/07/07	88/06/16
00036	WIND	DIR.FROM	NORTH-0	WATER		21	214.5200	3549.800	59.58000	300	90	82/07/07	88/06/16
00065	STREAM	STAGE	FEET	WATER		34	2.885300	2.943100	1.715600	6.00	.10	82/07/07	88/05/12
00067	TIDE	STAGE	CODE	WATER		34	3751.200	4911500	2216.200	7510	1010	82/07/07	88/05/12
00076	TURB	TRBIDMTR	HACH FTU	WATER		4	1.027500	.6771600	.8229000	2.2	.4	88/03/24	90/06/21
00078	TRANSP	SECCHI	METERS	WATER		28	1.665400	1.666400	1.290900	8.00	1.00	84/08/22	88/06/16
					L	2	1.700000	.0800000	.2828400	1.90	1.50	84/10/17	88/03/24
					TOT	30	1.667700	1.554300	1.246700	8.00	1.00	84/08/22	88/06/16
00094	CNDUCTVY	FIELD	MICROMHO	WATER		214	48595.00	17259000	4154.400	57400	28200	79/10/10	90/05/23
00095	CNDUCTVY	AT 25C	MICROMHO	WATER		4	50250.00	248490.0	498.4900	51000	50000	88/03/24	90/06/21
00300	DO		MG/L	WATER		206	6.801700	1.571800	1.253700	11.9	3.8	79/10/10	90/05/23
00301	DO	SATUR	PERCENT	WATER	$	203	73.49400	206.7500	14.37900	129.3	43.2	79/10/10	90/05/23
00400	PH		SU	WATER		214	7.909800	.0879550	.2965700	9.10	7.10	79/10/10	90/05/23
00403	PH	LAB	SU	WATER		4	8.000000	.0066732	.0816900	8.1	7.9	88/03/24	90/06/21
00530	RESIDUE	TOT NFLT	MG/L	WATER		1	31.00000			31	31	90/06/21	90/06/21
					K	3	5.000000	.0000000	.0000000	5	5	88/03/24	90/04/12
					TOT	4	11.50000	169.0000	13.00000	31	5	88/03/24	90/06/21
00535	RESIDUE	VOL NFLT	MG/L	WATER		1	12.00000			12	12	90/06/21	90/06/21
					K	3	5.000000	.0000000	.0000000	5	5	88/03/24	90/04/12
					TOT	4	6.750000	12.25000	3.500000	12	5	88/03/24	90/06/21
00610	NH3+NH4-	N TOTAL	MG/L	WATER		4	.2500000	.0033333	.0577350	.300	.200	88/03/24	90/06/21
00612	UN-IONZD	NH3-N	MG/L	WATER	$	1	.0017154			.002	.002	90/04/12	90/04/12
00619	UN-IONZD	NH3-NH3	MG/L	WATER	$	1	.0020858			.002	.002	90/04/12	90/04/12
00625	TOT KJEL	N	MG/L	WATER		4	.8250000	.0825010	.2872300	1.200	.500	88/03/24	90/06/21
00650	T PO4	PO4	MG/L	WATER		2	.3000000	.0000000	.0000000	.30	.30	90/04/12	90/06/21
					K	2	.5000000	.0000000	.0000000	.50	.50	88/03/24	88/05/12
					TOT	4	.4000000	.0133340	.1154700	.50	.30	88/03/24	90/06/21
01034	CHROMIUM	CR,TOT	UG/L	WATER	K	4	22.50000	408.3300	20.20700	40	5	88/03/24	90/06/21
01042	COPPER	CU,TOT	UG/L	WATER		1	40.00000			40	40	90/06/21	90/06/21
					K	3	20.00000	.0000000	.0000000	20	20	88/03/24	90/04/12
					TOT	4	25.00000	100.0000	10.00000	40	20	88/03/24	90/06/21
01051	LEAD	PB,TOT	UG/L	WATER	K	4	102.0000	12805.00	113.1600	200	4	88/03/24	90/06/21
01092	ZINC	ZN,TOT	UG/L	WATER		1	10.00000			10	10	87/05/21	87/05/21
					K	4	25.00000	33.33300	5.773500	30	20	88/03/24	90/06/21
					TOT	5	22.00000	70.00000	8.366600	30	10	87/05/21	90/06/21

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PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
71850	NITRATE	TOT-NO3	MG/L	WATER		1	.3500000			.4	.4	90/04/12	90/04/12
					K	3	.3333300	.0133330	.1154700	.4	.2	88/03/24	90/06/21
					TOT	4	.3375000	.0089584	.0946490	.4	.2	88/03/24	90/06/21
74041	WQF	SAMPLE	UPDATED	WATER		121	888870.0	1166E+05	10798.00	900821	861212	86/03/20	90/06/21

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21CAOCFC 770210 18070201
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PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00003	VSAMPLOC	DEPTH	FEET	WATER		2	9.500000	24.50000	4.949800	13	6	78/04/12	78/08/09
00010	WATER	TEMP	CENT	BOTTOM		1	21.80000			21.8	21.8	91/08/13	91/08/13
				WATER		499	19.66900	12.57700	3.546400	28.7	1.8	76/12/21	91/08/13
00011	WATER	TEMP	FAHN	BOTTOM	$	1	71.24000			71.2	71.2	91/08/13	91/08/13
				WATER	$	499	67.40300	40.66300	6.376700	83.7	35.3	76/12/21	91/08/13
00035	WIND	VELOCITY	MPH	WATER		67	4.567200	8.643200	2.939900	15.0	.0	78/12/13	91/08/13
00036	WIND	DIR.FROM	NORTH-0	WATER		62	222.4200	2775.200	52.68000	315	0	79/01/10	91/08/13
00065	STREAM	STAGE	FEET	WATER		99	2.658600	2.165100	1.471400	6.00	-.60	76/12/21	88/04/28
					K	1	.1000000			.10	.10	87/04/22	87/04/22
					TOT	100	2.633000	2.208700	1.486200	6.00	-.60	76/12/21	88/04/28
00067	TIDE	STAGE	CODE	WATER		100	3768.900	4760700	2181.900	7510	1010	76/12/21	88/04/28
00076	TURB	TRBIDMTR	HACH FTU	WATER		99	1.725700	17.23300	4.151200	37.0	.2	76/12/21	91/08/13
00078	TRANSP	SECCHI	METERS	WATER		35	1.957200	.2731100	.5226000	3.40	1.25	84/05/22	91/08/13
00094	CNDUCTVY	FIELD	MICROMHO	BOTTOM		1	51400.00			51400	51400	91/08/13	91/08/13
				WATER		485	47268.00	23232000	4820.000	56200	5000	77/01/27	91/08/13
00095	CNDUCTVY	AT 25C	MICROMHO	WATER		97	42808.00	58982000	7680.000	67000	12200	76/12/21	91/08/13
00116	INTNSVE	SURVEY	IDENT	WATER		2	730600.0	.0000000	.0000000	730601	730601	78/02/16	79/01/10
00300	DO		MG/L	BOTTOM		1	4.400000			4.4	4.4	91/08/13	91/08/13
				WATER		487	6.731700	3.119900	1.766300	17.0	.2	76/12/21	91/08/13
00301	DO	SATUR	PERCENT	BOTTOM	$	1	50.00000			50.0	50.0	91/08/13	91/08/13
				WATER	$	479	72.53000	383.2700	19.57700	142.9	2.3	76/12/21	91/08/13
00310	BOD	5 DAY	MG/L	WATER		4	5.500000	20.33300	4.509300	12.0	2.0	78/04/12	79/10/10
00335	COD	LOWLEVEL	MG/L	WATER		27	291.9300	77845.00	279.0100	1155.0	10.0	77/06/08	79/06/13
					K	2	1.000000	.0000000	.0000000	1.0	1.0	78/01/12	78/12/13
					TOT	29	271.8600	77913.00	279.1300	1155.0	1.0	77/06/08	79/06/13
00400	PH		SU	BOTTOM		1	7.400000			7.40	7.40	91/08/13	91/08/13
				WATER		485	7.945100	.1270200	.3564000	9.60	3.50	76/12/21	91/08/13
00403	PH	LAB	SU	WATER		99	7.864800	.0459580	.2143800	8.3	7.0	76/12/21	91/08/13
00530	RESIDUE	TOT NFLT	MG/L	WATER		81	46.71900	12928.00	113.7000	800	.6	76/12/21	91/08/13
					K	18	4.011100	3.643400	1.908800	5	.2	80/01/24	90/04/12
					TOT	99	38.95400	10828.00	104.0600	800	.2	76/12/21	91/08/13
00535	RESIDUE	VOL NFLT	MG/L	WATER		71	21.45400	1454.500	38.13800	270	.2	77/04/13	90/06/21
					K	24	3.508300	4.658200	2.158300	5	.2	80/01/24	91/08/13
					TOT	95	16.92000	1145.800	33.84900	270	.2	77/04/13	91/08/13
00550	OIL-GRSE	TOT-SXLT	MG/L	WATER		9	2.490000	3.612700	1.900700	5.5	.1	78/04/12	82/11/10
					K	1	.5000000			.5	.5	79/05/10	79/05/10
					TOT	10	2.291000	3.607300	1.899300	5.5	.1	78/04/12	82/11/10
00610	NH3+NH4-	N TOTAL	MG/L	WATER		66	.3934800	.2004300	.4477000	3.300	.090	77/01/27	91/08/13
					K	32	.0984370	.0000782	.0088433	.100	.050	76/12/21	85/05/22

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21CAOCFC 770210 18070201
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PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00610 NH3+NH4- N TOTAL MG/L	WATER	TOT	98	.2971400	.1536800	.3920200	3.300	.050	76/12/21	91/08/13
00612 UN-IONZD NH3-N MG/L	WATER	$	88	.0121710	.0002342	.0153040	.094	.001	76/12/21	91/08/13
00619 UN-IONZD NH3-NH3 MG/L	WATER	$	88	.0147980	.0003462	.0186080	.115	.001	76/12/21	91/08/13
00625 TOT KJEL N MG/L	WATER		89	.9693200	.7506700	.8664100	6.300	.100	76/12/21	90/06/21
		K	9	.1333300	.0025000	.0500000	.200	.100	78/12/13	91/08/13
		TOT	98	.8925500	.7401100	.8603000	6.300	.100	76/12/21	91/08/13
00650 T PO4 PO4 MG/L	WATER		74	.3085100	.0279590	.1672100	.92	.06	76/12/21	91/08/13
		K	25	.2462000	.0449360	.2119800	.50	.01	77/08/10	90/01/25
		TOT	99	.2927800	.0325720	.1804800	.92	.01	76/12/21	91/08/13
00668 PHOS MUD DRY WGT MG/KG-P	WATER		1	430.0000			430.0	430.0	83/05/11	83/05/11
00745 SULFIDE TOTAL MG/L	WATER		1	.0000000			.00	.00	84/05/22	84/05/22
00747 SULFIDE IN SED. MG/KG	WATER		1	70.00000			70.00	70.00	83/05/11	83/05/11
00955 SILICA DISOLVED MG/L	WATER		37	1.073800	.6870500	.8288800	3.5	.2	76/12/21	80/11/13
		K	11	.5090900	.1629100	.4036200	1.0	.1	77/09/14	80/07/09
		TOT	48	.9443700	.6184400	.7864100	3.5	.1	76/12/21	80/11/13
01002 ARSENIC AS,TOT UG/L	WATER		4	13.97500	318.8700	17.85700	40	.9	82/06/03	87/05/21
		K	12	7.583300	17.90200	4.231000	16	2	77/07/13	89/01/19
		TOT	16	9.181300	85.07200	9.223500	40	.9	77/07/13	89/01/19
01003 ARSENIC SEDMG/KG DRY WGT	WATER		2	7.750000	78.12500	8.838800	14.00	1.50	83/05/11	89/02/16
01027 CADMIUM CD,TOT UG/L	WATER		16	15.50000	552.6700	23.50900	91	1	76/12/21	83/05/11
		K	18	7.388900	39.42800	6.279200	20	1	77/04/13	89/01/19
		TOT	34	11.20600	288.4100	16.98300	91	1	76/12/21	89/01/19
01028 CD MUD DRY WGT MG/KG-CD	BOTTOM	K	1	.4000000			.40	.40	91/08/13	91/08/13
	WATER		2	.8400000	.2592000	.5091200	1.20	.48	81/11/12	83/05/11
		K	1	1.000000			1.00	1.00	89/02/16	89/02/16
		TOT	3	.8933300	.1381300	.3716600	1.20	.48	81/11/12	89/02/16
01029 CHROMIUM SEDMG/KG DRY WGT	BOTTOM		1	17.00000			17.00	17.00	91/08/13	91/08/13
	WATER		4	16.22500	53.40300	7.307700	26.00	8.90	81/11/12	90/01/25
01034 CHROMIUM CR,TOT UG/L	WATER		36	23.21100	569.7700	23.87000	120	1	77/05/11	87/09/23
		K	29	16.80400	512.8900	22.64700	100	.3	76/12/21	90/06/21
		TOT	65	20.35200	546.2800	23.37300	120	.3	76/12/21	90/06/21
01042 COPPER CU,TOT UG/L	WATER		52	46.75000	1195.600	34.57700	130	1	77/02/09	90/06/21
		K	38	21.18400	302.0500	17.38000	70	2	77/09/14	90/04/12
		TOT	90	35.95600	971.9100	31.17600	130	1	77/02/09	90/06/21
01043 COPPER SEDMG/KG DRY WGT	BOTTOM		1	38.00000			38.00	38.00	91/08/13	91/08/13
	WATER		4	34.00000	156.0000	12.49000	49.00	19.00	81/11/12	90/01/25
01045 IRON FE,TOT UG/L	WATER		1	150.0000			150	150	86/10/15	86/10/15
01051 LEAD PB,TOT UG/L	WATER		40	12.00000	82.51300	9.083700	40	1	76/12/21	82/11/10
		K	51	18.21600	1433.200	37.85800	200	1	77/02/09	90/06/21

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01051 LEAD PB,TOT UG/L	WATER	TOT	91	15.48400	841.6100	29.01100	200	1	76/12/21	90/06/21
01052 LEAD SEDMG/KG DRY WGT	BOTTOM		1	56.00000			56.00	56.00	91/08/13	91/08/13
	WATER		4	93.50000	3269.700	57.18100	176.00	53.00	81/11/12	90/01/25
01068 NICKEL SEDMG/KG DRY WGT	BOTTOM		1	9.400000			9.40	9.40	91/08/13	91/08/13
01078 SILVER SEDMG/KG DRY WGT	BOTTOM	K	1	.2000000			.20	.20	91/08/13	91/08/13
01092 ZINC ZN,TOT UG/L	WATER		70	42.27200	1160.500	34.06600	220	2	76/12/21	90/01/25
		K	22	21.59100	890.8300	29.84700	150	5	77/04/13	90/06/21
		TOT	92	37.32600	1164.200	34.12000	220	2	76/12/21	90/06/21
01093 ZINC SEDMG/KG DRY WGT	BOTTOM		1	110.0000			110.00	110.00	91/08/13	91/08/13
	WATER		5	106.6000	1461.800	38.23400	166.00	60.00	81/11/12	90/01/25
01102 TIN SN,TOT UG/L	WATER	K	2	2565.000	11859000	3443.600	5000	130	79/05/10	86/10/15
01147 SELENIUM SE,TOT UG/L	WATER		1	2.000000			2	2	77/07/13	77/07/13
		K	14	12.65000	218.2100	14.77200	50	.1	78/04/12	89/07/13
		TOT	15	11.94000	210.1800	14.49800	50	.1	77/07/13	89/07/13
01148 SELENIUM SEDMG/KG DRY WGT	WATER	K	1	.1000000			.10	.10	83/05/11	83/05/11
01170 FE MUD DRY WGT MG/KG-FE	WATER		1	.6000000			.60	.60	89/07/13	89/07/13
32730 PHENOLS TOTAL UG/L	WATER		1	50.00000			50	50	77/07/13	77/07/13
		K	10	30.00000	311.1100	17.63800	50	10	78/04/12	82/11/10
		TOT	11	31.81800	316.3700	17.78700	50	10	77/07/13	82/11/10
34203 ACNAPTHY SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34208 ACNAPTHE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34223 ANTHRACE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34233 BENZBFLU ORANTMUD DRYUG/KG	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34245 BENZKFLU SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34250 BENZAPYR SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34257 BETA BHC SEDUG/KG DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
34259 DELTABHC TOTUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34262 DELTABHC SEDUG/KG DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
34323 CHRYSENE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34337 DIETHYLP HTHALATE DISSUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34338 DIETHYLP HTHALATE SUSPUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34351 ENDSULSF TOTUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34354 ENDSULSF SEDUG/KG DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
34356 B-ENDO SULFAN TOTWUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34359 BENDOSUL SEDUG/KG DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
34361 A-ENDO SULFAN TOTWUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34364 AENDOSUL SEDUG/KG DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
34369 ENDRINAL SEDUG/KG DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
34379 FLANTENE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13

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CHRISTIANA BAY, MIDBASIN
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
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21CAOCFC 770210 18070201
0999 FEET DEPTH

/TYPA/AMBNT/ESTURY

	PARAMETER			MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
34384	FLUORENE	SEDUG/KG	DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34406	I123CDPR	SEDUG/KG	DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34445	NAPTHALE	SEDUG/KG	DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34464	PHENANTH	SEDUG/KG	DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34472	PYRENE	SEDUG/KG	DRY WGT	BOTTOM	K	1	.4000000			.400	.400	91/08/13	91/08/13
34529	BENZAANT	SEDUG/KG	DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34559	DBAHANTH	SEDUG/KG	DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34671	PCB	1016	TOTWUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
38260	MBAS		MG/L	WATER		2	.0450000	.0012500	.0353550	.07	.02	80/10/15	81/05/20
					K	5	.0460000	.0024300	.0492950	.10	.01	79/05/10	82/11/10
					TOT	7	.0457140	.0018286	.0427620	.10	.01	79/05/10	82/11/10
39034	PERTHANE	WHL SMPL	UG/L	WATER	K	2	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39055	SIMAZINE	WH.WATER	(UG/L)	WATER	K	1	10.00000			10	10	82/11/10	82/11/10
39076	ALPHABHC	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
39301	P,P'DDT	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
39311	P,P'DDD	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
39321	P,P'DDE	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
39330	ALDRIN		TOT UG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39333	ALDRIN	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
				WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39340	GAMMABHC	LINDANE	TOT.UG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39343	GBHC-MUD	LINDANE	DRYUG/KG	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
				WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39350	CHLRDANE	TECH&MET	TOT UG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39351	CDANEDRY	TECH&MET	MUDUG/KG	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
				WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39360	DDD	WHL SMPL	UG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39363	DDD	MUD	UG/KG	WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39365	DDE	WHL SMPL	UG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39368	DDE	MUD	UG/KG	WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39370	DDT	WHL SMPL	UG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39373	DDT	MUD	UG/KG	WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39380	DIELDRIN		TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39383	DIELDRIN	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
				WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39390	ENDRIN		TOT UG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39393	ENDRIN	SEDUG/KG	DRY WGT	BOTTOM	K	1	20.00000			20.00	20.00	91/08/13	91/08/13
				WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39400	TOXAPHEN		TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10

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21CAOCFC 770210 18070201
0999 FEET DEPTH

/TYPA/AMBNT/ESTURY

PARAMETER		MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
39403 TOXAPHEN SEDUG/KG	DRY WGT	BOTTOM	K	1	2000.000			2000.00	2000.00	91/08/13	91/08/13
		WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39410 HEPTCHLR	TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39413 HEPTCHLR SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
		WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39420 HPCHLREP	TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39423 HPCHLREP SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
		WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39480 MTHXYCLR WHL SMPL	UG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39481 MTHXYCLR MUD DRY	UG/KG	BOTTOM	K	1	70.00000			70.00	70.00	91/08/13	91/08/13
		WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39488 PCB-1221	TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39491 PCB-1221 SEDUG/KG	DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39492 PCB-1232	TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39495 PCB-1232 SEDUG/KG	DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39496 PCB-1242	TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39499 PCB-1242 SEDUG/KG	DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39500 PCB-1248	TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39503 PCB-1248 SEDUG/KG	DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	1	20.00000			20.00	20.00	82/06/03	82/06/03
39504 PCB-1254	TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39507 PCB-1254 SEDUG/KG	DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39508 PCB-1260	TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39511 PCB-1260 SEDUG/KG	DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
39514 PCB-1016 SEDUG/KG	DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	1	20.00000			20.00	20.00	81/11/12	81/11/12
39530 MALATHN WHL SMPL	UG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
39531 MALATHN MUD	UG/KG	BOTTOM	K	1	30.00000			30.00	30.00	91/08/13	91/08/13
		WATER	K	1	20.00000			20.00	20.00	81/11/12	81/11/12
39540 PARATHN WHL SMPL	UG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
39541 PARATHN MUD	UG/KG	BOTTOM	K	1	30.00000			30.00	30.00	91/08/13	91/08/13
		WATER	K	1	20.00000			20.00	20.00	81/11/12	81/11/12
39730 2,4-D WHL SMPL	UG/L	WATER	K	3	10.00000	.0000000	.0000000	10.000	10.000	81/11/12	82/11/10
39731 2,4-D MUD	UG/KG	BOTTOM	K	1	5000.000			5000.00	5000.00	91/08/13	91/08/13

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SANTA ANA RIVER BASIN 140700
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21CAOCFC 770210 18070201
0999 FEET DEPTH

/TYPA/AMBNT/ESTURY

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
39731	2,4-D	MUD	UG/KG	WATER	K	2	100.0000	.0000000	.0000000	100.00	100.00	81/11/12	82/06/03
39760	SILVEX	WHL SMPL	UG/L	WATER	K	3	10.00000	.0000000	.0000000	10.000	10.000	81/11/12	82/11/10
39761	SILVEX	MUD	UG/KG	BOTTOM	K	1	2000.000			2000.00	2000.00	91/08/13	91/08/13
				WATER	K	2	100.0000	.0000000	.0000000	100.00	100.00	81/11/12	82/06/03
39782	LINDANE	WHL SMPL	UG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39783	LINDANE	MUD DRY	UG/KG	WATER	K	2	20.00000	.0000000	.0000000	20.00	20.00	81/11/12	82/06/03
71850	NITRATE	TOT-NO3	MG/L	WATER		66	2.397000	6.169400	2.483800	10.0	.2	76/12/21	90/05/23
					K	33	.3751500	.0247760	.1574000	1.0	.1	77/08/10	91/08/13
					TOT	99	1.723000	5.017700	2.240000	10.0	.1	76/12/21	91/08/13
71885	IRON	FE	UG/L	WATER		2	145.0000	50.00000	7.071100	150.00	140.00	77/07/13	86/10/15
71900	MERCURY	HG,TOTAL	UG/L	WATER		9	3.055600	12.22300	3.496100	11.0	.2	77/07/13	83/05/11
					K	7	.8428600	.2828600	.5318400	2.0	.5	78/11/08	89/07/13
					TOT	16	2.087500	7.917200	2.813800	11.0	.2	77/07/13	89/07/13
71921	MERCURY	SEDMG/KG	DRY WGT	WATER		2	.1100000	.0008000	.0282850	.1	.09	81/11/12	83/05/11
					K	2	.3000000	.0200000	.1414200	.4	.2	89/02/16	89/07/13
					TOT	4	.2050000	.0189670	.1377200	.4	.09	81/11/12	89/07/13
74041	WQF	SAMPLE	UPDATED	BOTTOM		1	920110.0			920109	920109	91/08/13	91/08/13
				WATER		211	888340.0	1589E+05	12606.00	920109	860715	85/10/16	91/08/13
78453	PCB-1262	SED DRY	WT UG/KG	BOTTOM	K	1	100.0000			100.000	100.000	91/08/13	91/08/13
78828	BZO(GHI)	PERYLENE	SEDUG/KG	BOTTOM	K	1	.2000000			.20	.20	91/08/13	91/08/13
81886	PERTHANE	SED DRY	WGTUG/KG	BOTTOM	K	1	70000.00			70000.00	70000.00	91/08/13	91/08/13

SUNC07
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C07 AT HEIL AVENUE BRIDGE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN

/TYPA/AMBNT/LAKE

21CAOCFC 770826 18070201
0999 FEET DEPTH

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER		14	17.53600	21.24900	4.609700	26.0	12.0	73/10/02	83/03/24
00011	WATER	TEMP	FAHN	WATER	$	14	63.56400	68.86100	8.298200	78.8	53.6	73/10/02	83/03/24
00061	STREAM	FLOW,	INST-CFS	WATER	J	9	14.69500	95.09000	9.751400	25	.3	77/05/10	83/03/24
00076	TURB	TRBIDMTR	HACH FTU	WATER		14	47.70700	1409.600	37.54400	100.0	1.6	73/05/08	83/03/24
00094	CNDUCTVY	FIELD	MICROMHO	WATER		11	1799.100	7724000	2779.200	10000	140	77/05/10	83/03/24
00095	CNDUCTVY	AT 25C	MICROMHO	WATER		20	17162.00	4002E+05	20006.00	50720	200	73/04/17	83/03/24
00116	INTNSVE	SURVEY	IDENT	WATER		14	678420.0	3812E+07	195260.0	730601	0	77/05/10	83/03/24
00300	DO		MG/L	WATER		10	9.640000	5.765000	2.401000	14.4	5.0	77/05/10	83/03/24
					L	1	15.00000			15.0	15.0	78/01/06	78/01/06
					TOT	11	10.12700	7.800300	2.792900	15.0	5.0	77/05/10	83/03/24
00301	DO	SATUR	PERCENT	WATER	$	11	106.4900	882.1200	29.70100	150.0	51.5	77/05/10	83/03/24
00335	COD	LOWLEVEL	MG/L	WATER		5	120.8000	10682.00	103.3500	280.0	23.0	77/07/12	78/03/01
					K	2	1.500000	.5000000	.7071100	2.0	1.0	77/12/27	78/02/09
					TOT	7	86.71400	10510.00	102.5200	280.0	1.0	77/07/12	78/03/01
00400	PH		SU	WATER		9	7.355600	.4803200	.6930500	8.30	6.00	77/05/10	83/03/24
00403	PH	LAB	SU	WATER		20	7.655000	.3289200	.5735200	8.6	6.8	73/04/17	83/03/24
00405	CO2		MG/L	WATER		2	1.000000	2.000000	1.414200	2.0	.0	77/05/10	77/07/12
00440	HCO3 ION	HCO3	MG/L	WATER		4	156.0000	2535.300	50.35200	194	83	73/05/08	77/07/12
00445	CO3 ION	CO3	MG/L	WATER		3	2.800000	23.52000	4.849800	8	0	73/05/08	77/07/12
00530	RESIDUE	TOT NFLT	MG/L	WATER		18	92.82200	6802.600	82.47800	341	10	73/04/17	83/03/24
00535	RESIDUE	VOL NFLT	MG/L	WATER		12	46.09200	1450.900	38.09000	111	5	77/05/10	83/03/24
00550	OIL-GRSE	TOT-SXLT	MG/L	WATER		3	5.100000	18.01000	4.243800	10.0	2.6	78/01/06	82/03/17
00610	NH3+NH4-	N TOTAL	MG/L	WATER		12	.6858300	1.465100	1.210400	4.300	.000	73/06/04	83/03/24
					K	8	.1000000	.0000000	.0000000	.100	.100	73/04/17	80/01/29
					TOT	20	.4515000	.9349400	.9669200	4.300	.000	73/04/17	83/03/24
00612	UN-IONZD	NH3-N	MG/L	WATER	$	14	.0097568	.0004671	.0216130	.083	.00005	73/10/02	83/03/24
00615	NO2-N	TOTAL	MG/L	WATER	K	1	.1000000			.100	.100	73/10/02	73/10/02
00619	UN-IONZD	NH3-NH3	MG/L	WATER	$	14	.0118630	.0006905	.0262790	.101	.00006	73/10/02	83/03/24
00625	TOT KJEL	N	MG/L	WATER		20	3.279000	24.48500	4.948300	23.000	.500	73/04/17	83/03/24
00650	T PO4	PO4	MG/L	WATER		20	.6920000	.2083200	.4564200	1.68	.02	73/04/17	83/03/24
00900	TOT HARD	CACO3	MG/L	WATER		3	4661.700	9699500	3114.400	6596	1069	73/06/04	77/07/12
00915	CALCIUM	CA,DISS	MG/L	WATER		4	311.8800	27660.00	166.3100	400.0	62.5	73/05/08	77/07/12
00925	MGNSIUM	MG,DISS	MG/L	WATER		4	980.0000	275320.0	524.7100	1360.0	220.0	73/05/08	77/07/12
00930	SODIUM	NA,DISS	MG/L	WATER		4	7825.000	17483000	4181.200	10800.00	1800.00	73/05/08	77/07/12
00935	PTSSIUM	K,DISS	MG/L	WATER		4	336.7500	30686.00	175.1800	444.00	77.00	73/05/08	77/07/12
00940	CHLORIDE	TOTAL	MG/L	WATER		4	14253.00	57647000	7592.600	19380	3183	73/05/08	77/07/12
00945	SULFATE	SO4-TOT	MG/L	WATER		4	2010.500	1131200	1063.600	2835	463	73/05/08	77/07/12
00950	FLUORIDE	F,DISS	MG/L	WATER		4	.9350000	.2755700	.5249400	1.40	.20	73/05/08	77/07/12
00955	SILICA	DISOLVED	MG/L	WATER		16	5.331300	16.49400	4.061300	14.0	.5	73/04/17	80/01/29

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C07 AT HEIL AVENUE BRIDGE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN

/TYPA/AMBNT/LAKE

21CAOCFC 770826 18070201
0999 FEET DEPTH

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
01002	ARSENIC	AS,TOT	UG/L	WATER	K	1	2.000000			2	2	77/07/12	77/07/12
01020	BORON	B,DISS	UG/L	WATER		4	2206.000	3860900	1964.900	4000	4	73/05/08	77/07/12
01027	CADMIUM	CD,TOT	UG/L	WATER		8	8.250000	136.5000	11.68300	36	2	73/07/16	78/03/01
01034	CHROMIUM	CR,TOT	UG/L	WATER		7	85.28600	26312.00	162.2100	450	9	77/07/12	82/01/05
					K	4	8.250000	20.25000	4.500000	12	2	78/03/01	83/03/24
					TOT	11	57.27300	17304.00	131.5400	450	2	77/07/12	83/03/24
01037	COBALT	CO,TOTAL	UG/L	WATER	K	1	2.000000			2	2	78/03/01	78/03/01
01042	COPPER	CU,TOT	UG/L	WATER		14	26.28600	382.5300	19.55800	86	8	73/07/16	83/03/24
01051	LEAD	PB,TOT	UG/L	WATER		14	158.4300	21736.00	147.4300	530	8	73/06/04	83/03/24
					K	1	5.000000			5	5	73/09/17	73/09/17
					TOT	15	148.2000	21753.00	147.4900	530	5	73/06/04	83/03/24
01092	ZINC	ZN,TOT	UG/L	WATER		12	99.50000	2489.400	49.89400	190	34	77/07/12	83/03/24
					K	1	5.000000			5	5	73/07/16	73/07/16
					TOT	13	92.23100	2968.900	54.48700	190	5	73/07/16	83/03/24
01147	SELENIUM	SE,TOT	UG/L	WATER	K	1	2.000000			2	2	77/07/12	77/07/12
31507	TOT COLI	MPN COMP	/100ML	WATER		9	508110.0	6200E+08	787420.0	2400000	24000	77/12/27	82/01/05
32730	PHENOLS	TOTAL	UG/L	WATER	K	1	.0500000			.05	.05	77/07/12	77/07/12
46570	CAL HARD	CA MG	MG/L	WATER	$	4	4814.400	6586100	2566.300	6599	1062	73/05/08	77/07/12
70301	DISS SOL	SUM	MG/L	WATER		4	25811.00	1878E+05	13708.00	35180	5854	73/05/08	77/07/12
71850	NITRATE	TOT-NO3	MG/L	WATER		18	4.827800	23.73400	4.871700	17.5	.0	73/04/17	83/03/24
					K	2	.1000000	.0000000	.0000000	.1	.1	73/07/09	73/10/02
					TOT	20	4.355000	23.35300	4.832500	17.5	.0	73/04/17	83/03/24
71885	IRON	FE	UG/L	WATER		1	920.0000			920.00	920.00	77/07/12	77/07/12
71900	MERCURY	HG,TOTAL	UG/L	WATER	K	1	.2000000			.2	.2	77/07/12	77/07/12

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ENTRANCE OF BOLSA CHICA CHANNEL
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
HUNTINGTON HARBOUR
21CAOCFC 770210 HQ 18070201001 0010.180 OFF
0999 FEET DEPTH

/TYPA/AMBNT/ESTURY

PARAMETER					MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT		BOTTOM		1	19.70000			19.7	19.7	91/08/13	91/08/13
					WATER		465	18.97600	8.882400	2.980300	25.9	12.2	76/11/22	91/08/13
00011	WATER	TEMP	FAHN		BOTTOM	$	1	67.46000			67.5	67.5	91/08/13	91/08/13
					WATER	$	465	66.15600	28.72200	5.359300	78.6	54.0	76/11/22	91/08/13
00035	WIND	VELOCITY	MPH		WATER		62	5.735500	12.04300	3.470300	20.0	.0	78/12/13	91/08/13
00036	WIND	DIR.FROM	NORTH-0		WATER		60	218.7500	2866.700	53.54100	315	0	78/12/13	91/08/13
00065	STREAM	STAGE	FEET		WATER		97	2.575400	2.176500	1.475300	5.80	-.80	76/11/22	88/05/12
						K	2	.0500000	.0050000	.0707110	.10	.00	84/02/16	87/04/22
						TOT	99	2.524300	2.259700	1.503200	5.80	-.80	76/11/22	88/05/12
00067	TIDE	STAGE	CODE		WATER		99	3800.900	4973800	2230.200	7410	1010	76/11/22	88/05/12
00076	TURB	TRBIDMTR	HACH FTU		WATER		102	2.141700	26.92800	5.189200	50.0	.2	76/11/22	91/08/13
						K	1	.1000000			.1	.1	88/06/16	88/06/16
						TOT	103	2.121800	26.70500	5.167700	50.0	.1	76/11/22	91/08/13
00078	TRANSP	SECCHI	METERS		WATER		30	1.681700	.2914700	.5398800	3.00	.75	84/05/22	91/08/13
00094	CNDUCTVY	FIELD	MICROMHO		BOTTOM		1	50800.00			50800	50800	91/08/13	91/08/13
					WATER		444	47312.00	27035000	5199.600	56400	4600	77/01/27	91/08/13
00095	CNDUCTVY	AT 25C	MICROMHO		WATER		101	42692.00	68146000	8255.000	69000	2550	76/11/22	91/08/13
00116	INTNSVE	SURVEY	IDENT		WATER		2	730600.0	.0000000	.0000000	730601	730601	78/02/16	79/01/10
00300	DO		MG/L		BOTTOM		1	6.000000			6.0	6.0	91/08/13	91/08/13
					WATER		447	7.149200	1.690100	1.300000	12.4	4.2	76/11/22	91/08/13
00301	DO	SATUR	PERCENT		BOTTOM	$	1	65.21700			65.2	65.2	91/08/13	91/08/13
					WATER	$	444	76.07200	192.4100	13.87100	121.6	46.7	76/11/22	91/08/13
00310	BOD	5 DAY	MG/L		WATER		3	3.333300	.3333400	.5773600	4.0	3.0	78/11/08	81/05/20
						K	1	3.000000			3.0	3.0	79/10/10	79/10/10
						TOT	4	3.250000	.2500000	.5000000	4.0	3.0	78/11/08	81/05/20
00335	COD	LOWLEVEL	MG/L		WATER		24	221.9600	61479.00	247.9500	1070.0	23.0	77/06/08	79/05/10
						K	2	5.500000	40.50000	6.364000	10.0	1.0	78/01/12	79/02/15
						TOT	26	205.3100	60022.00	245.0000	1070.0	1.0	77/06/08	79/05/10
00400	PH		SU		BOTTOM		1	7.600000			7.60	7.60	91/08/13	91/08/13
					WATER		448	7.969400	.0997540	.3158400	9.40	6.20	76/11/22	91/08/13
00403	PH	LAB	SU		WATER		102	7.851300	.0579360	.2407000	8.4	6.8	76/11/22	91/08/13
00530	RESIDUE	TOT NFLT	MG/L		WATER		83	48.02300	11928.00	109.2200	760	.8	76/11/22	91/08/13
						K	20	5.000000	.0000000	.0000000	5	5	86/11/19	90/04/12
						TOT	103	39.66900	9881.800	99.40700	760	.8	76/11/22	91/08/13
00535	RESIDUE	VOL NFLT	MG/L		WATER		72	22.35100	1371.400	37.03200	260	.4	77/04/13	90/06/21
						K	27	4.181500	3.070000	1.752200	5	.4	77/12/14	91/08/13
						TOT	99	17.39600	1060.500	32.56500	260	.4	77/04/13	91/08/13
00550	OIL-GRSE	TOT-SXLT	MG/L		WATER		11	10.91800	260.5800	16.14300	56.4	.4	78/11/08	85/10/16
						K	3	1.866700	7.403300	2.720900	5.0	.1	79/05/10	86/10/15

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21CAOCFC 770210 HQ 18070201001 0010.180 OFF
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PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00550 OIL-GRSE TOT-SXLT MG/L	WATER	TOT	14	8.978600	216.4400	14.71200	56.4	.1	78/11/08	86/10/15
00610 NH3+NH4- N TOTAL MG/L	WATER		73	.4023300	.4328000	.6578700	5.400	.050	76/11/22	91/08/13
		K	30	.1133300	.0053334	.0730300	.500	.100	76/12/21	85/05/22
		TOT	103	.3181500	.3244300	.5695900	5.400	.050	76/11/22	91/08/13
00612 UN-IONZD NH3-N MG/L	WATER	$	92	.0125160	.0005834	.0241560	.193	.0005	76/11/22	91/08/13
00619 UN-IONZD NH3-NH3 MG/L	WATER	$	92	.0152180	.0008626	.0293700	.235	.0006	76/11/22	91/08/13
00625 TOT KJEL N MG/L	WATER		94	.9369100	.7199500	.8485000	6.400	.200	76/11/22	90/06/21
		K	9	.1555600	.0177780	.1333300	.500	.100	78/11/08	91/08/13
		TOT	103	.8686400	.7069800	.8408200	6.400	.100	76/11/22	91/08/13
00650 T PO4 PO4 MG/L	WATER		78	.3367900	.0526910	.2295500	1.38	.03	76/11/22	91/08/13
		K	25	.2942000	.0456410	.2136400	.50	.01	76/12/21	90/05/23
		TOT	103	.3264600	.0508520	.2255000	1.38	.01	76/11/22	91/08/13
00668 PHOS MUD DRY WGT MG/KG-P	WATER		8	453.3900	433130.0	658.1300	1600.0	11.0	78/04/12	85/10/16
00680 T ORG C C MG/L	WATER		2	1951.100	7596400	2756.200	3900.0	2.2	83/11/09	86/10/15
00745 SULFIDE TOTAL MG/L	WATER		1	.0000000			.00	.00	84/05/22	84/05/22
00747 SULFIDE IN SED. MG/KG	WATER		2	80.00000	.0000000	.0000000	80.00	80.00	82/06/03	83/05/11
		K	5	1.160000	.1280000	.3577700	1.80	1.00	82/11/10	85/10/16
		TOT	7	23.68600	1480.000	38.47100	80.00	1.00	82/06/03	85/10/16
00955 SILICA DISOLVED MG/L	WATER		33	1.130300	.8971900	.9472000	3.7	.1	76/11/22	80/11/13
		K	14	.4714300	.1329700	.3646500	1.0	.1	77/02/09	80/07/09
		TOT	47	.9340400	.7544700	.8686000	3.7	.1	76/11/22	80/11/13
01002 ARSENIC AS,TOT UG/L	WATER		5	12.76000	260.7300	16.14700	40	.9	82/06/03	87/05/21
		K	16	8.937500	55.12900	7.424900	28	2	77/07/13	89/01/19
		TOT	21	9.847600	96.27700	9.812100	40	.9	77/07/13	89/01/19
01003 ARSENIC SEDMG/KG DRY WGT	WATER		18	5.455600	32.20300	5.674700	21.00	.70	78/04/12	89/01/19
01027 CADMIUM CD,TOT UG/L	WATER		16	14.06300	445.2600	21.10100	82	1	76/12/21	85/10/16
		K	21	7.404800	62.49100	7.905100	30	.5	76/11/22	89/01/19
		TOT	37	10.28400	231.4300	15.21300	82	.5	76/11/22	89/01/19
01028 CD MUD DRY WGT MG/KG-CD	BOTTOM	K	1	.4000000			.40	.40	91/08/13	91/08/13
	WATER		16	1.161900	.3468200	.5889100	2.50	.25	78/04/12	89/01/19
		K	3	.6666700	.0433340	.2081700	.90	.50	83/11/09	89/01/18
		TOT	19	1.083700	.3282500	.5729300	2.50	.25	78/04/12	89/01/19
01029 CHROMIUM SEDMG/KG DRY WGT	BOTTOM		1	15.00000			15.00	15.00	91/08/13	91/08/13
	WATER		20	16.69000	63.04700	7.940200	34.00	3.00	78/04/12	90/01/25
01034 CHROMIUM CR,TOT UG/L	WATER		36	24.43300	759.9800	27.56800	140	1	77/04/13	89/08/16
		K	35	16.38300	426.5700	20.65400	100	.1	76/11/22	90/06/21
		TOT	71	20.46500	603.6100	24.56900	140	.1	76/11/22	90/06/21
01042 COPPER CU,TOT UG/L	WATER		58	46.99700	2672.400	51.69500	320	1	77/02/09	90/06/21
		K	37	21.59500	326.2500	18.06200	70	1	77/09/14	90/01/25

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PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
01042	COPPER	CU,TOT	UG/L	WATER	TOT	95	37.10300	1900.500	43.59500	320	1	77/02/09	90/06/21
01043	COPPER	SEDMG/KG	DRY WGT	BOTTOM		1	23.00000			23.00	23.00	91/08/13	91/08/13
				WATER		20	40.59500	250.5400	15.82800	85.00	18.00	78/04/12	90/01/25
01045	IRON	FE,TOT	UG/L	WATER		6	137.3300	3330.700	57.71200	210	54	83/11/09	86/10/15
01051	LEAD	PB,TOT	UG/L	WATER		43	15.44200	197.1600	14.04100	63	1	76/12/21	89/08/16
					K	55	20.60000	1816.100	42.61600	200	1	76/11/22	90/06/21
					TOT	98	18.33700	1103.000	33.21200	200	1	76/11/22	90/06/21
01052	LEAD	SEDMG/KG	DRY WGT	BOTTOM		1	24.00000			24.00	24.00	91/08/13	91/08/13
				WATER		15	101.0700	3522.400	59.35000	244.00	19.00	78/04/12	90/01/25
01068	NICKEL	SEDMG/KG	DRY WGT	BOTTOM		1	7.500000			7.50	7.50	91/08/13	91/08/13
01078	SILVER	SEDMG/KG	DRY WGT	BOTTOM	K	1	.2000000			.20	.20	91/08/13	91/08/13
01092	ZINC	ZN,TOT	UG/L	WATER		72	44.58300	1475.500	38.41200	190	5	76/11/22	90/01/25
					K	27	21.70400	734.9900	27.11100	150	5	77/04/13	90/06/21
					TOT	99	38.34400	1368.900	36.99800	190	5	76/11/22	90/06/21
01093	ZINC	SEDMG/KG	DRY WGT	BOTTOM		1	110.0000			110.00	110.00	91/08/13	91/08/13
				WATER		21	149.1000	10896.00	104.3800	570.00	51.00	78/04/12	90/01/25
01102	TIN	SN,TOT	UG/L	WATER	K	6	1941.700	3825400	1955.900	5000	20	79/05/10	86/10/15
01103	TIN MUD	DRY WGT	MG/KG-SN	WATER		2	51.50000	2244.500	47.37600	85.00	18.00	79/05/10	85/10/16
					K	1	125.0000			125.00	125.00	84/12/12	84/12/12
					TOT	3	76.00000	2923.000	54.06500	125.00	18.00	79/05/10	85/10/16
01143	SILICON	SILICATE	UG/L SI	WATER	K	1	2.000000			2	2	84/05/22	84/05/22
01147	SELENIUM	SE,TOT	UG/L	WATER		4	3.275000	12.70300	3.564100	8	.1	77/07/13	86/10/15
					K	16	23.28100	1395.900	37.36100	150	.5	78/11/08	89/07/13
					TOT	20	19.28000	1171.400	34.22600	150	.1	77/07/13	89/07/13
01148	SELENIUM	SEDMG/KG	DRY WGT	WATER		3	1.906700	6.326900	2.515300	4.80	.24	78/04/12	81/05/20
					K	9	.7166700	.4284800	.6545800	1.80	.07	78/11/08	85/10/16
					TOT	12	1.014200	1.751600	1.323500	4.80	.07	78/04/12	85/10/16
01170	FE MUD	DRY WGT	MG/KG-FE	WATER		4	14250.00	1329E+05	11529.00	27000.00	.50	83/11/09	89/07/13
01501	ALPHA	TOTAL	PC/L	WATER		3	.0280000	.0010290	.0320780	.06	0	89/01/19	89/02/01
					K	1	3.000000			3	3	81/05/20	81/05/20
					TOT	4	.7710000	2.208900	1.486200	3	0	81/05/20	89/02/01
01502	ALPHA-T	ERROR	PC/L	WATER		1	.3000000			.3	.3	81/05/20	81/05/20
03501	BETA	TOTAL	PC/L	WATER		3	11.84600	419.6300	20.48500	36	.01	89/01/19	89/02/01
					K	1	4.000000			4	4	81/05/20	81/05/20
					TOT	4	9.884500	295.1500	17.18000	36	.01	81/05/20	89/02/01
03502	BETA-T	ERROR	PC/L	WATER		1	1.000000			1	1	81/05/20	81/05/20
09501	RA-226	TOTAL	PC/L	WATER	K	1	.5000000			.5	.5	81/05/20	81/05/20
09502	RA-226	ERROR	PC/L	WATER		1	.1000000			.1	.1	81/05/20	81/05/20
32730	PHENOLS	TOTAL	UG/L	WATER	K	10	34.00000	293.3300	17.12700	50	10	77/07/13	82/11/10

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	PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
34203	ACNAPTHY SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34208	ACNAPTHE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34223	ANTHRACE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34233	BENZBFLU ORANTMUD DRYUG/KG	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34245	BENZKFLU SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34250	BENZAPYR SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34257	BETA BHC SEDUG/KG DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
		WATER	K	8	8.875300	38.69100	6.220200	20.000	.002	82/11/10	89/01/19
34259	DELTABHC TOTUG/L	WATER	K	10	.1234000	.0953370	.3087700	1.000	.002	82/11/10	89/01/19
34262	DELTABHC SEDUG/KG DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
		WATER	K	8	8.875300	38.69100	6.220200	20.000	.002	82/11/10	89/01/19
34323	CHRYSENE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34337	DIETHYLP HTHALATE DISSUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34338	DIETHYLP HTHALATE SUSPUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34351	ENDSULSF TOTUG/L	WATER	K	10	1.150600	9.756300	3.123500	10.000	.003	82/11/10	89/01/19
34354	ENDSULSF SEDUG/KG DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
		WATER	K	8	25.12500	364.3900	19.08900	50.000	.003	82/11/10	89/01/19
34356	B-ENDO SULFAN TOTWUG/L	WATER	K	10	.1254000	.0948730	.3080100	1.000	.002	82/11/10	89/01/19
34359	BENDOSUL SEDUG/KG DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
		WATER	K	8	11.37500	95.11900	9.752900	30.000	.002	82/11/10	89/01/19
34361	A-ENDO SULFAN TOTWUG/L	WATER		1	.0020000			.002	.002	89/01/19	89/01/19
			K	9	.1391100	.1046200	.3234500	1.000	.002	82/11/10	89/01/19
			TOT	10	.1254000	.0948730	.3080100	1.000	.002	82/11/10	89/01/19
34364	AENDOSUL SEDUG/KG DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
		WATER	K	8	11.37500	95.11900	9.752900	30.000	.002	82/11/10	89/01/19
34369	ENDRINAL SEDUG/KG DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
34379	FLANTENE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34384	FLUORENE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34406	I123CDPR SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34445	NAPTHALE SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34464	PHENANTH SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34472	PYRENE SEDUG/KG DRY WGT	BOTTOM	K	1	.4000000			.400	.400	91/08/13	91/08/13
34529	BENZAANT SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34559	DBAHANTH SEDUG/KG DRY WGT	BOTTOM	K	1	.2000000			.200	.200	91/08/13	91/08/13
34671	PCB 1016 TOTWUG/L	WATER	K	12	.6633300	.1810600	.4255100	1.000	.030	81/11/12	89/01/19
38260	MBAS MG/L	WATER		6	.2550000	.0632300	.2514600	.65	.01	80/10/15	86/10/15
			K	5	.0640000	.0024300	.0492950	.10	.01	79/05/10	84/12/12
			TOT	11	.1681800	.0425370	.2062400	.65	.01	79/05/10	86/10/15
39034	PERTHANE WHL SMPL UG/L	WATER	K	14	.9647200	.4785100	.6917400	3.000	.003	79/05/10	89/01/19

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PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
39046	SIMAZINE	MUD	UG/GK	WATER	K	6	1015.800	3962400	1990.600	5000.00	5.00	79/05/10	88/01/21
39055	SIMAZINE	WH.WATER	(UG/L)	WATER	K	12	1.816700	8.334300	2.886900	10	.1	79/05/10	89/01/19
39057	PRMETRYN	WH.WATER	(UG/L)	WATER	K	1	.1000000			.1	.1	89/01/19	89/01/19
39076	ALPHABHC	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.000	10.000	91/08/13	91/08/13
				WATER	K	7	8.571700	39.28000	6.267400	20.000	.002	82/11/10	89/01/19
39301	P,P'DDT	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
39311	P,P'DDD	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
39321	P,P'DDE	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
39330	ALDRIN		TOT UG/L	WATER		1	.0040000			.004	.004	89/01/19	89/01/19
					K	18	.4702800	.2383300	.4882000	1.000	.005	77/07/13	89/01/19
					TOT	19	.4457400	.2365400	.4863500	1.000	.004	77/07/13	89/01/19
39333	ALDRIN	SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
				WATER		1	.0040000			.004	.004	89/01/19	89/01/19
					K	13	11.26900	60.44200	7.774500	20.00	.50	78/11/08	88/01/21
					TOT	14	10.46500	64.85800	8.053400	20.00	.004	78/11/08	89/01/19
39337	ALPHABHC		TOTUG/L	WATER	K	9	.0243330	.0005942	.0243770	.050	.002	83/11/09	89/01/19
39338	BETA BHC		TOTUG/L	WATER	K	9	.0260000	.0005280	.0229780	.050	.002	83/11/09	89/01/19
39340	GAMMABHC	LINDANE	TOT.UG/L	WATER	K	14	.5971400	.2335000	.4832200	1.000	.010	77/07/13	85/10/16
39343	GBHC-MUD	LINDANE	DRYUG/KG	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
				WATER	K	10	12.65000	69.55800	8.340200	20.00	.50	78/11/08	84/12/12
39350	CHLRDANE	TECH&MET	TOT UG/L	WATER	K	19	.5115800	.1909800	.4370100	1.000	.010	77/07/13	89/01/19
39351	CDANEDRY	TECH&MET	MUDUG/KG	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
				WATER		1	270.0000			270.00	270.00	80/05/14	80/05/14
					K	13	38.11600	1486.500	38.55600	100.00	.01	78/11/08	89/01/19
					TOT	14	54.67900	5212.900	72.20100	270.00	.01	78/11/08	89/01/19
39360	DDD	WHL SMPL	UG/L	WATER	K	19	.4439000	.2381400	.4880000	1.000	.002	77/07/13	89/01/19
39363	DDD	MUD	UG/KG	WATER		2	14.50000	60.50000	7.778200	20.00	9.00	83/05/11	84/05/22
					K	12	12.12500	60.09200	7.751900	20.00	.002	78/11/08	89/01/19
					TOT	14	12.46500	56.24500	7.499700	20.00	.002	78/11/08	89/01/19
39365	DDE	WHL SMPL	UG/L	WATER		3	.0103330	.0000053	.0023094	.013	.009	89/01/19	89/01/19
					K	17	.4958800	.2406300	.4905400	1.000	.010	77/07/13	88/01/21
					TOT	20	.4230500	.2342700	.4840200	1.000	.009	77/07/13	89/01/19
39368	DDE	MUD	UG/KG	WATER		3	20.33800	690.0700	26.26900	50.00	.01	83/05/11	89/01/19
					K	11	13.22700	50.06800	7.075900	20.00	.50	78/11/08	88/01/21
					TOT	14	14.75100	153.8500	12.40400	50.00	.01	78/11/08	89/01/19
39370	DDT	WHL SMPL	UG/L	WATER	K	19	.4560000	.2283600	.4778700	1.000	.002	77/07/13	89/01/19
39373	DDT	MUD	UG/KG	WATER		1	5.000000			5.00	5.00	83/05/11	83/05/11
					K	13	17.34600	92.80200	9.633400	30.00	.002	78/11/08	89/01/19
					TOT	14	16.46500	96.55200	9.826100	30.00	.002	78/11/08	89/01/19

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39380 DIELDRIN	TOTUG/L	WATER		1	.0110000			.011	.011	89/01/19	89/01/19
			K	18	.4684500	.2400200	.4899200	1.000	.002	77/07/13	89/01/19
			TOT	19	.4443700	.2377000	.4875500	1.000	.002	77/07/13	89/01/19
39381 DIELDRIN	DISUG/L	WATER	K	1	20.00000			20.000	20.000	80/05/14	80/05/14
39383 DIELDRIN SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
		WATER	K	14	11.17900	59.75100	7.729900	20.00	.002	78/11/08	89/01/19
39390 ENDRIN	TOT UG/L	WATER	K	19	.4545300	.2297200	.4793000	1.000	.003	77/07/13	89/01/19
39393 ENDRIN SEDUG/KG	DRY WGT	BOTTOM	K	1	20.00000			20.00	20.00	91/08/13	91/08/13
		WATER	K	13	15.07700	80.90300	8.994600	30.00	.003	79/05/10	89/01/19
39400 TOXAPHEN	TOTUG/L	WATER	K	19	.7263200	.1528800	.3910000	1.000	.050	77/07/13	89/01/19
39403 TOXAPHEN SEDUG/KG	DRY WGT	BOTTOM	K	1	2000.000			2000.00	2000.00	91/08/13	91/08/13
		WATER	K	14	129.6800	35129.00	187.4300	500.00	.05	78/11/08	89/01/19
39410 HEPTCHLR	TOTUG/L	WATER	K	20	.4219500	.2352400	.4850100	1.000	.003	77/07/13	89/01/19
39413 HEPTCHLR SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
		WATER	K	14	11.17900	59.74900	7.729800	20.00	.003	78/11/08	89/01/19
39420 HPCHLREP	TOTUG/L	WATER	K	19	.4439000	.2381400	.4880000	1.000	.002	77/07/13	89/01/19
39423 HPCHLREP SEDUG/KG	DRY WGT	BOTTOM	K	1	10.00000			10.00	10.00	91/08/13	91/08/13
		WATER	K	14	11.17900	59.75100	7.729900	20.00	.002	78/11/08	89/01/19
39480 MTHXYCLR WHL SMPL	UG/L	WATER	K	17	.6129400	.1870900	.4325300	1.000	.010	79/05/10	89/01/19
39481 MTHXYCLR MUD DRY	UG/KG	BOTTOM	K	1	70.00000			70.00	70.00	91/08/13	91/08/13
		WATER	K	10	43.10100	1724.900	41.53200	100.00	.01	79/10/10	89/01/19
39488 PCB-1221	TOTUG/L	WATER	K	12	.6633300	.1810600	.4255100	1.000	.030	81/11/12	89/01/19
39491 PCB-1221 SEDUG/KG	DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	9	150.0000	21049.00	145.0800	300.00	.03	81/11/12	89/01/19
39492 PCB-1232	TOTUG/L	WATER	K	19	.7400000	.1598600	.3998200	1.000	.030	77/07/13	89/01/19
39495 PCB-1232 SEDUG/KG	DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	14	101.1100	17616.00	132.7200	300.00	.03	78/11/08	89/01/19
39496 PCB-1242	TOTUG/L	WATER	K	19	.7400000	.1598600	.3998200	1.000	.030	77/07/13	89/01/19
39499 PCB-1242 SEDUG/KG	DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	14	101.1100	17616.00	132.7200	300.00	.03	78/11/08	89/01/19
39500 PCB-1248	TOTUG/L	WATER	K	12	.6633300	.1810600	.4255100	1.000	.030	81/11/12	89/01/19
39503 PCB-1248 SEDUG/KG	DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	8	166.2500	21340.00	146.0800	300.00	.03	82/06/03	89/01/19
39504 PCB-1254	TOTUG/L	WATER	K	20	.7045000	.1766500	.4203000	1.000	.030	77/07/13	89/01/19
39507 PCB-1254 SEDUG/KG	DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	13	108.8500	18175.00	134.8200	300.00	.03	79/05/10	89/01/19
39508 PCB-1260	TOTUG/L	WATER	K	19	.7400000	.1598600	.3998200	1.000	.030	77/07/13	89/01/19
39511 PCB-1260 SEDUG/KG	DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	14	101.1100	17616.00	132.7200	300.00	.03	78/11/08	89/01/19

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39514	PCB-1016 SEDUG/KG DRY WGT	BOTTOM	K	1	100.0000			100.00	100.00	91/08/13	91/08/13
		WATER	K	8	166.2500	21340.00	146.0800	300.00	.03	81/11/12	89/01/19
39530	MALATHN WHL SMPL UG/L	WATER	K	13	.8538500	.1272800	.3567600	1.000	.050	79/05/10	89/01/19
39531	MALATHN MUD UG/KG	BOTTOM	K	1	30.00000			30.00	30.00	91/08/13	91/08/13
		WATER	K	10	129.5100	94890.00	308.0400	1000.00	.05	79/05/10	89/01/19
39533	MALATHN SUS FRAC UG/L	WATER	K	1	.0500000			.050	.050	89/01/19	89/01/19
39540	PARATHN WHL SMPL UG/L	WATER	K	14	1.439300	6.231200	2.496300	10.000	.050	79/05/10	89/01/19
39541	PARATHN MUD UG/KG	BOTTOM	K	1	30.00000			30.00	30.00	91/08/13	91/08/13
		WATER	K	10	1029.500	9935900	3152.100	10000.00	.05	79/05/10	89/01/19
39730	2,4-D WHL SMPL UG/L	WATER	K	12	3.175000	18.68500	4.322700	10.000	.050	81/11/12	89/01/19
39731	2,4-D MUD UG/KG	BOTTOM	K	1	5000.000			5000.00	5000.00	91/08/13	91/08/13
		WATER	K	10	111.0100	20209.00	142.1600	500.00	.05	81/11/12	89/01/19
39760	SILVEX WHL SMPL UG/L	WATER	K	12	2.743300	19.27100	4.389900	10.000	.010	81/11/12	89/01/19
39761	SILVEX MUD UG/KG	BOTTOM	K	1	2000.000			2000.00	2000.00	91/08/13	91/08/13
		WATER	K	10	59.00100	2032.100	45.07900	100.00	.01	81/11/12	89/01/19
39780	DICOFOL WHL SMPL UG/L	WATER	K	6	.7000000	.2160000	.4647600	1.000	.100	77/07/13	80/10/15
39782	LINDANE WHL SMPL UG/L	WATER	K	17	.4843500	.2513900	.5013800	1.000	.002	79/05/10	89/01/19
39783	LINDANE MUD DRY UG/KG	WATER	K	13	12.00000	54.49600	7.382200	20.00	.002	79/05/10	89/01/19
71850	NITRATE TOT-NO3 MG/L	WATER		69	3.619300	40.85400	6.391700	50.0	.1	76/11/22	90/04/12
			K	34	.3670600	.0244340	.1563100	1.0	.1	76/12/21	91/08/13
			TOT	103	2.545700	29.60600	5.441100	50.0	.1	76/11/22	91/08/13
71885	IRON FE UG/L	WATER		3	2013.300	10755000	3279.500	5800.00	90.00	77/07/13	86/10/15
71900	MERCURY HG,TOTAL UG/L	WATER		7	3.700000	18.41700	4.291500	13.0	.4	77/07/13	83/05/11
			K	13	.8923100	.2174400	.4663000	2.0	.2	79/10/10	89/07/13
			TOT	20	1.875000	7.840900	2.800200	13.0	.2	77/07/13	89/07/13
71921	MERCURY SEDMG/KG DRY WGT	WATER		10	.1813000	.0664970	.2578700	.9	.03	78/11/08	85/10/16
			K	10	.2880000	.0229510	.1515000	.4	.02	78/04/12	89/07/13
			TOT	20	.2346500	.0453660	.2129900	.9	.02	78/04/12	89/07/13
74041	WQF SAMPLE UPDATED	BOTTOM		1	920110.0			920109	920109	91/08/13	91/08/13
		WATER		210	887990.0	1479E+05	12163.00	920109	860715	85/08/13	91/08/13
78453	PCB-1262 SED DRY WT UG/KG	BOTTOM	K	1	100.0000			100.000	100.000	91/08/13	91/08/13
78828	BZO(GHI) PERYLENE SEDUG/KG	BOTTOM	K	1	.2000000			.20	.20	91/08/13	91/08/13
80101	CARBON DRY WGT MG/KG	WATER		3	11757.00	2016E+05	14200.00	28000.0	1700.0	83/11/09	85/10/16
81886	PERTHANE SED DRY WGTUG/KG	BOTTOM	K	1	70000.00			70000.00	70000.00	91/08/13	91/08/13
		WATER	K	6	80.00100	12920.00	113.6700	300.000	.003	82/11/10	89/01/19
82007	% SAND IN SED DRY WGT	WATER		7	59.31400	639.2300	25.28300	94.00	14.20	82/06/03	87/05/21
82008	SEDIMENT PARTSIZE SILT	WATER		7	33.37200	641.9700	25.33700	80.60	2.00	82/06/03	87/05/21
82009	SEDIMENT PARTSIZE CLAY	WATER		7	7.314300	14.42500	3.798000	13.00	2.00	82/06/03	87/05/21
82302	RADON222 TOT.CT. ER PC/L	WATER		1	1.000000			1.00	1.00	81/05/20	81/05/20

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82303 RADON222	TOTAL	PC/L	WATER	K	1	1.000000			1.00	1.00	81/05/20	81/05/20

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00010 WATER	TEMP	CENT		WATER		134	18.36200	6.871900	2.621400	25.6	12.4	76/11/22	90/04/12
00011 WATER	TEMP	FAHN		WATER	$	134	65.05000	22.37700	4.730400	78.1	54.3	76/11/22	90/04/12
00035 WIND	VELOCITY	MPH		WATER		58	3.810400	14.79700	3.846700	15.0	.0	79/02/15	88/05/12
					K	1	1.000000			1.0	1.0	87/02/11	87/02/11
					TOT	59	3.762700	14.67600	3.830900	15.0	.0	79/02/15	88/05/12
00036 WIND	DIR.FROM	NORTH-0		WATER		48	202.9800	5359.900	73.21100	315	0	79/03/14	88/06/16
00061 STREAM	FLOW,	INST-CFS		WATER		1	1100.000			1100	1100	87/05/21	87/05/21
00065 STREAM	STAGE	FEET		WATER		94	3.343100	2.952100	1.718200	6.80	.00	76/11/22	88/05/12
00067 TIDE	STAGE	CODE		WATER		92	3351.300	4342800	2083.900	7510	1010	76/11/22	88/05/12
00076 TURB	TRBIDMTR	HACH FTU		WATER		87	1.102000	.8971700	.9471900	5.7	.2	76/11/22	90/05/23
00078 TRANSP	SECCHI	METERS		WATER		22	2.104600	.2071300	.4551100	3.00	1.00	84/08/22	88/06/16
00094 CNDUCTVY	FIELD	MICROMHO		WATER		130	47782.00	14545000	3813.800	56300	34500	77/01/27	90/04/12
00095 CNDUCTVY	AT 25C	MICROMHO		WATER		87	45244.00	26829000	5179.600	67000	33900	76/11/22	90/05/23
00116 INTNSVE	SURVEY	IDENT		WATER		2	730600.0	.0000000	.0000000	730601	730601	78/02/16	79/01/10
00300 DO		MG/L		WATER		130	8.976600	2.252900	1.501000	13.2	5.8	76/12/21	90/04/12
					L	1	15.00000			15.0	15.0	76/11/22	76/11/22
					TOT	131	9.022500	2.512500	1.585100	15.0	5.8	76/11/22	90/04/12
00301 DO	SATUR	PERCENT		WATER	$	131	95.00700	323.2100	17.97800	157.9	58.0	76/11/22	90/04/12
00310 BOD	5 DAY	MG/L		WATER		3	11.66700	90.33400	9.504400	21.0	2.0	78/04/12	79/10/10
00335 COD	LOWLEVEL	MG/L		WATER		23	269.0400	46812.00	216.3600	750.0	20.0	77/06/08	79/06/13
					K	1	1.000000			1.0	1.0	78/01/12	78/01/12
					TOT	24	257.8800	47770.00	218.5600	750.0	1.0	77/06/08	79/06/13
00400 PH		SU		WATER		132	8.053200	.0951220	.3084200	9.90	7.40	76/11/22	90/04/12
00403 PH	LAB	SU		WATER		86	7.909100	.0707720	.2660300	8.4	7.0	76/11/22	90/05/23
00530 RESIDUE	TOT NFLT	MG/L		WATER		74	49.90500	13438.00	115.9200	710	.8	76/11/22	90/05/23
					K	13	4.076900	3.201900	1.789400	5	.5	81/05/20	90/04/12
					TOT	87	43.05800	11677.00	108.0600	710	.5	76/11/22	90/05/23
00535 RESIDUE	VOL NFLT	MG/L		WATER		64	23.14500	1541.900	39.26700	250	.4	77/04/13	90/05/23
					K	17	3.235300	4.847400	2.201700	5	.5	77/08/10	90/04/12
					TOT	81	18.96700	1281.800	35.80200	250	.4	77/04/13	90/05/23
00550 OIL-GRSE	TOT-SXLT	MG/L		WATER		8	5.407500	55.14400	7.425900	23.0	1.2	78/04/12	82/11/10
					K	1	.5000000			.5	.5	79/05/10	79/05/10
					TOT	9	4.862200	50.92700	7.136300	23.0	.5	78/04/12	82/11/10
00610 NH3+NH4-	N TOTAL	MG/L		WATER		57	.4845600	.6622800	.8138100	6.000	.050	76/11/22	90/05/23
					K	30	.1133300	.0053334	.0730300	.500	.100	76/12/21	85/05/22
					TOT	87	.3565500	.4645500	.6815800	6.000	.050	76/11/22	90/05/23
00612 UN-IONZD	NH3-N	MG/L		WATER	$	79	.0178560	.0011191	.0334530	.226	.0010	76/11/22	90/04/12
00619 UN-IONZD	NH3-NH3	MG/L		WATER	$	79	.0217110	.0016545	.0406750	.275	.001	76/11/22	90/04/12
00625 TOT KJEL	N	MG/L		WATER		79	.9832900	1.287800	1.134800	8.700	.020	76/11/22	90/05/23

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AT HARBOR ENTRANCE - MIDCHANNEL
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
/TYPA/AMBNT/ESTURY
HUNTINGTON HARBOUR
21CAOCFC 770222 18070301
0999 FEET DEPTH

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00625	TOT KJEL	N	MG/L	WATER	K	8	.1750000	.0192860	.1388700	.500	.100	78/12/13	84/10/17
00625	TOT KJEL	N	MG/L	WATER	TOT	87	.9089600	1.224800	1.106700	8.700	.020	76/11/22	90/05/23
00650	T PO4	PO4	MG/L	WATER		65	.3187700	.1435200	.3788400	2.54	.06	76/11/22	90/05/23
					K	23	.2154400	.0430160	.2074000	.50	.01	77/08/10	89/07/13
					TOT	88	.2917600	.1185400	.3443000	2.54	.01	76/11/22	90/05/23
00955	SILICA	DISOLVED	MG/L	WATER		21	2.571400	40.96100	6.400100	30.0	.1	77/04/13	81/01/14
					K	24	.4625000	.1372300	.3704400	1.0	.1	76/11/22	80/11/13
					TOT	45	1.446700	19.82300	4.452300	30.0	.1	76/11/22	81/01/14
01002	ARSENIC	AS,TOT	UG/L	WATER		2	20.50000	180.5000	13.43500	30	11	82/06/03	83/05/11
					K	12	7.083300	18.26500	4.273800	16	2	77/07/13	89/01/19
					TOT	14	9.000000	53.07700	7.285400	30	2	77/07/13	89/01/19
01020	BORON	B,DISS	UG/L	WATER		1	7400.000			7400	7400	78/08/09	78/08/09
01027	CADMIUM	CD,TOT	UG/L	WATER		17	17.35300	504.1200	22.45300	86	1	76/12/21	83/05/11
					K	15	6.466700	31.69500	5.629900	20	1	76/11/22	89/01/19
					TOT	32	12.25000	304.9700	17.46300	86	1	76/11/22	89/01/19
01034	CHROMIUM	CR,TOT	UG/L	WATER		32	27.23100	918.0000	30.29900	140	.4	77/06/08	88/01/21
					K	26	14.50000	281.5400	16.77900	60	1	76/11/22	90/04/12
					TOT	58	21.52400	663.5400	25.75900	140	.4	76/11/22	90/04/12
01042	COPPER	CU,TOT	UG/L	WATER		43	40.86100	983.8400	31.36600	100	2	77/02/09	88/10/14
					K	37	21.43500	309.0200	17.57900	70	.1	77/09/14	90/04/12
					TOT	80	31.87600	758.8700	27.54800	100	.1	77/02/09	90/04/12
01045	IRON	FE,TOT	UG/L	WATER		1	690.0000			690	690	86/10/15	86/10/15
01051	LEAD	PB,TOT	UG/L	WATER		36	12.25000	62.87900	7.929600	36	1	76/11/22	90/04/12
					K	46	19.02200	1573.200	39.66400	200	2	77/02/09	89/04/19
					TOT	82	16.04900	912.6200	30.21000	200	1	76/11/22	90/04/12
01092	ZINC	ZN,TOT	UG/L	WATER		56	35.68000	791.4000	28.13200	130	.1	76/11/22	89/01/19
					K	28	19.71400	708.7300	26.62200	150	5	77/04/13	90/05/23
					TOT	84	30.35800	812.3100	28.50100	150	.1	76/11/22	90/05/23
01102	TIN	SN,TOT	UG/L	WATER	K	2	2565.000	11859000	3443.600	5000	130	79/05/10	86/10/15
01147	SELENIUM	SE,TOT	UG/L	WATER		2	33.50000	1300.500	36.06300	59	8	78/04/12	82/06/03
					K	10	7.500000	49.61100	7.043500	20	1	77/07/13	89/07/13
					TOT	12	11.83300	261.2400	16.16300	59	1	77/07/13	89/07/13
01501	ALPHA	TOTAL	PC/L	WATER		1	.0070000			.007	.007	89/03/23	89/03/23
03501	BETA	TOTAL	PC/L	WATER		1	.0930000			.09	.09	89/03/23	89/03/23
32730	PHENOLS	TOTAL	UG/L	WATER	K	10	33.00000	334.4500	18.28800	50	10	77/07/13	82/11/10
34259	DELTABHC		TOTUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34337	DIETHYLP	HTHALATE	DISSUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34338	DIETHYLP	HTHALATE	SUSPUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34351	ENDSULSF		TOTUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10

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PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
34356	B-ENDO	SULFAN	TOTWUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34361	A-ENDO	SULFAN	TOTWUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34671	PCB	1016	TOTWUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
38260	MBAS		MG/L	WATER		4	.0650000	.0061667	.0785280	.18	.01	80/10/15	82/11/10
					K	3	.0400000	.0027000	.0519620	.10	.01	79/05/10	82/06/03
					TOT	7	.0542860	.0041619	.0645130	.18	.01	79/05/10	82/11/10
39034	PERTHANE	WHL SMPL	UG/L	WATER	K	2	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39055	SIMAZINE	WH.WATER	(UG/L)	WATER	K	1	10.00000			10	10	82/11/10	82/11/10
39330	ALDRIN		TOT UG/L	WATER	K	4	.7750000	.2025000	.4500000	1.000	.100	77/07/13	82/11/10
39340	GAMMABHC	LINDANE	TOT.UG/L	WATER	K	4	.7750000	.2025000	.4500000	1.000	.100	77/07/13	82/11/10
39350	CHLRDANE	TECH&MET	TOT UG/L	WATER	K	4	.7750000	.2025000	.4500000	1.000	.100	77/07/13	82/11/10
39360	DDD	WHL SMPL	UG/L	WATER	K	4	.7750000	.2025000	.4500000	1.000	.100	77/07/13	82/11/10
39365	DDE	WHL SMPL	UG/L	WATER	K	4	.7750000	.2025000	.4500000	1.000	.100	77/07/13	82/11/10
39370	DDT	WHL SMPL	UG/L	WATER	K	4	.7750000	.2025000	.4500000	1.000	.100	77/07/13	82/11/10
39380	DIELDRIN		TOTUG/L	WATER	K	4	.7750000	.2025000	.4500000	1.000	.100	77/07/13	82/11/10
39390	ENDRIN		TOT UG/L	WATER	K	4	.7750000	.2025000	.4500000	1.000	.100	77/07/13	82/11/10
39400	TOXAPHEN		TOTUG/L	WATER	K	4	.7750000	.2025000	.4500000	1.000	.100	77/07/13	82/11/10
39410	HEPTCHLR		TOTUG/L	WATER	K	4	.7750000	.2025000	.4500000	1.000	.100	77/07/13	82/11/10
39420	HPCHLREP		TOTUG/L	WATER	K	4	.7750000	.2025000	.4500000	1.000	.100	77/07/13	82/11/10
39480	MTHXYCLR	WHL SMPL	UG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39488	PCB-1221		TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39492	PCB-1232		TOTUG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	77/07/13	82/11/10
39496	PCB-1242		TOTUG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	77/07/13	82/11/10
39500	PCB-1248		TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39504	PCB-1254		TOTUG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	77/07/13	82/11/10
39508	PCB-1260		TOTUG/L	WATER	K	4	1.000000	.0000000	.0000000	1.000	1.000	77/07/13	82/11/10
39530	MALATHN	WHL SMPL	UG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
39540	PARATHN	WHL SMPL	UG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
39730	2,4-D	WHL SMPL	UG/L	WATER	K	3	10.00000	.0000000	.0000000	10.000	10.000	81/11/12	82/11/10
39760	SILVEX	WHL SMPL	UG/L	WATER	K	3	10.00000	.0000000	.0000000	10.000	10.000	81/11/12	82/11/10
39780	DICOFOL	WHL SMPL	UG/L	WATER	K	1	.1000000			.100	.100	77/07/13	77/07/13
39782	LINDANE	WHL SMPL	UG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
71850	NITRATE	TOT-NO3	MG/L	WATER		50	2.295800	6.229100	2.495800	14.0	.1	76/11/22	90/04/12
					K	38	.3779000	.0229150	.1513800	1.0	.1	76/12/21	90/05/23
					TOT	88	1.467600	4.430900	2.105000	14.0	.1	76/11/22	90/05/23
71885	IRON	FE	UG/L	WATER		2	370.0000	204800.0	452.5500	690.00	50.00	77/07/13	86/10/15
71900	MERCURY	HG,TOTAL	UG/L	WATER		6	1.133300	.9266700	.9626400	3.0	.2	77/07/13	83/05/11
					K	10	1.090000	.6432200	.8020100	3.0	.5	78/11/08	89/07/13
					TOT	16	1.106300	.6952900	.8338400	3.0	.2	77/07/13	89/07/13

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SANTA ANA RIVER BASIN 140700
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0999 FEET DEPTH

/TYPA/AMBNT/ESTURY

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
74041	WQF	SAMPLE	UPDATED	WATER		64	888040.0	78826000	8878.400	900821	860729	85/07/25	90/05/23

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SOUTH SIDE OF PHASE TWO LAKE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
/TYPA/AMBNT/LAKE MILE SQUARE PARK
21CAOCFC 770210 18070201
0999 FEET DEPTH

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER		200	20.71300	24.12600	4.911800	29.5	10.0	76/11/11	90/04/03
00011	WATER	TEMP	FAHN	WATER	$	200	69.28100	78.36700	8.852500	85.1	50.0	76/11/11	90/04/03
00076	TURB	TRBIDMTR	HACH FTU	WATER		71	13.73600	4426.300	66.53000	560.0	.3	76/11/11	88/07/18
00078	TRANSP	SECCHI	METERS	WATER		9	1.144500	.2940300	.5422500	2.00	.50	85/07/17	88/06/21
00094	CNDUCTVY	FIELD	MICROMHO	WATER		155	384.2800	6778.700	82.33300	700	4	77/01/26	90/04/03
00095	CNDUCTVY	AT 25C	MICROMHO	WATER		70	448.6300	17369.00	131.7900	1100	300	76/11/11	88/07/18
00300	DO		MG/L	WATER		195	10.46700	7.250800	2.692700	18.3	.7	76/11/11	90/04/03
					L	4	15.00000	.0000000	.0000000	15.0	15.0	86/06/04	89/03/22
					TOT	199	10.55800	7.511200	2.740700	18.3	.7	76/11/11	90/04/03
00301	DO	SATUR	PERCENT	WATER	$	199	116.5900	1036.800	32.19900	193.6	7.1	76/11/11	90/04/03
00335	COD	LOWLEVEL	MG/L	WATER		17	40.52900	725.2700	26.93100	122.0	8.0	77/06/07	79/10/24
					K	1	3.000000			3.0	3.0	78/09/12	78/09/12
					TOT	18	38.44500	760.8500	27.58400	122.0	3.0	77/06/07	79/10/24
00400	PH		SU	WATER		156	8.688900	.3335900	.5775800	10.20	7.00	76/11/11	90/04/03
00403	PH	LAB	SU	WATER		71	8.027400	.2942000	.5424000	9.4	6.5	76/11/11	88/07/18
00405	CO2		MG/L	WATER		18	10.63300	539.0200	23.21700	97.0	.0	76/11/11	86/10/16
00440	HCO3 ION	HCO3	MG/L	WATER		16	141.8100	1493.200	38.64200	210	77	76/11/11	86/10/16
00445	CO3 ION	CO3	MG/L	WATER		2	.0000000	.0000000	.0000000	0	0	85/11/19	86/10/16
00515	RESIDUE	DISS-105 C	MG/L	WATER		1	200.0000			200	200	86/10/16	86/10/16
00530	RESIDUE	TOT NFLT	MG/L	WATER		61	32.38700	9174.200	95.78200	750	.4	76/11/11	88/07/18
					K	6	4.333300	2.666700	1.633000	5	1	85/11/19	88/05/09
					TOT	67	29.87500	8405.600	91.68200	750	.4	76/11/11	88/07/18
00535	RESIDUE	VOL NFLT	MG/L	WATER		51	27.15100	9483.600	97.38400	700	.2	77/05/10	88/07/18
					K	12	2.425000	5.222100	2.285200	5	.1	80/03/18	88/05/09
					TOT	63	22.44100	7744.800	88.00500	700	.1	77/05/10	88/07/18
00610	NH3+NH4-	N TOTAL	MG/L	WATER		45	.5451100	1.223400	1.106100	7.300	.030	76/11/11	88/01/25
					K	24	.1333300	.0127540	.1129300	.500	.100	77/02/08	88/07/18
					TOT	69	.4018800	.8349700	.9137700	7.300	.030	76/11/11	88/07/18
00612	UN-IONZD	NH3-N	MG/L	WATER	$	60	.0393820	.0044447	.0666690	.452	.0006	76/11/11	87/03/10
00619	UN-IONZD	NH3-NH3	MG/L	WATER	$	60	.0478850	.0065711	.0810620	.549	.0008	76/11/11	87/03/10
00625	TOT KJEL	N	MG/L	WATER		68	1.806500	5.207300	2.282000	17.000	.200	76/11/11	89/06/20
					K	2	.3500000	.0450000	.2121300	.500	.200	79/10/24	83/08/19
					TOT	70	1.764900	5.116700	2.262000	17.000	.200	76/11/11	89/06/20
00650	T PO4	PO4	MG/L	WATER		59	.7440700	8.767500	2.961000	23.00	.02	76/11/11	87/03/20
					K	10	.1860000	.0286270	.1692000	.50	.06	77/11/15	88/07/18
					TOT	69	.6631900	7.521100	2.742500	23.00	.02	76/11/11	88/07/18
00668	PHOS MUD	DRY WGT	MG/KG-P	WATER		5	416.0000	391240.0	625.4900	1500.0	18.0	83/05/12	85/11/19
00680	T ORG C	C	MG/L	WATER		6	92.68300	43838.00	209.3800	520.0	3.3	83/04/21	86/10/16
					K	1	3.000000			3.0	3.0	84/05/10	84/05/10

MSPLA2
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SOUTH SIDE OF PHASE TWO LAKE
06059 CALIFORNIA ORANGE
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MILE SQUARE PARK
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0999 FEET DEPTH

/TYPA/AMBNT/LAKE

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00680	T ORG C	C	MG/L	WATER	TOT	7	79.87100	37681.00	194.1200	520.0	3.0	83/04/21	86/10/16
00747	SULFIDE	IN SED.	MG/KG	WATER		1	2.000000			2.00	2.00	83/05/12	83/05/12
					K	4	1.000000	.0000000	.0000000	1.00	1.00	83/11/10	85/11/19
					TOT	5	1.200000	.2000000	.4472200	2.00	1.00	83/05/12	85/11/19
00900	TOT HARD	CACO3	MG/L	WATER		15	158.3300	3140.700	56.04200	242	35	76/11/11	86/10/16
00915	CALCIUM	CA,DISS	MG/L	WATER		16	54.37500	1855.300	43.07300	207.0	23.0	76/11/11	86/10/16
00925	MGNSIUM	MG,DISS	MG/L	WATER		16	13.51900	16.44200	4.054800	17.8	7.8	76/11/11	86/10/16
00930	SODIUM	NA,DISS	MG/L	WATER		16	43.43800	72.92900	8.539900	63.00	19.00	76/11/11	86/10/16
00935	PTSSIUM	K,DISS	MG/L	WATER		16	3.362500	.5665300	.7526800	5.60	2.40	76/11/11	86/10/16
00940	CHLORIDE	TOTAL	MG/L	WATER		16	43.93800	302.7300	17.39900	75	18	76/11/11	86/10/16
00945	SULFATE	SO4-TOT	MG/L	WATER		16	76.65600	969.2300	31.13200	107	19	76/11/11	86/10/16
00950	FLUORIDE	F,DISS	MG/L	WATER		15	.6886700	.0788410	.2807900	1.50	.40	76/11/11	86/10/16
00955	SILICA	DISOLVED	MG/L	WATER		44	15.31800	95.52900	9.773900	56.0	.6	76/11/11	86/10/16
01002	ARSENIC	AS,TOT	UG/L	WATER		2	4.000000	2.000000	1.414200	5	3	80/10/14	81/05/19
01020	BORON	B,DISS	UG/L	WATER		15	233.3300	37238.00	192.9700	750	100	76/11/11	85/11/19
					K	1	50.00000			50	50	86/10/16	86/10/16
					TOT	16	221.8800	36856.00	191.9800	750	50	76/11/11	86/10/16
01027	CADMIUM	CD,TOT	UG/L	WATER		3	3.000000	3.000000	1.732100	5	2	77/06/07	81/05/19
					K	3	1.833300	3.583300	1.893000	4	.5	77/08/09	84/11/07
					TOT	6	2.416700	3.041700	1.744000	5	.5	77/06/07	84/11/07
01029	CHROMIUM	SEDMG/KG	DRY WGT	WATER		1	3.300000			3.30	3.30	83/08/19	83/08/19
01034	CHROMIUM	CR,TOT	UG/L	WATER		3	22.66700	310.3300	17.61600	37	3	77/04/12	81/03/17
					K	10	4.500000	1.166700	1.080100	5	2	77/08/09	88/04/11
					TOT	13	8.692300	116.0700	10.77300	37	2	77/04/12	88/04/11
01042	COPPER	CU,TOT	UG/L	WATER		16	10.09400	79.80700	8.933500	29	1	76/11/11	88/04/11
					K	7	6.428600	5.952400	2.439800	10	5	77/02/08	88/01/25
					TOT	23	8.978300	59.01100	7.681900	29	1	76/11/11	88/04/11
01043	COPPER	SEDMG/KG	DRY WGT	WATER		6	7.650000	53.20300	7.294000	22.00	3.30	83/05/12	85/11/19
01045	IRON	FE,TOT	UG/L	WATER		1	250.0000			250	250	84/11/07	84/11/07
01051	LEAD	PB,TOT	UG/L	WATER		7	33.28600	498.2400	22.32100	74	12	77/04/12	81/03/17
					K	10	8.000000	40.44500	6.359600	24	3	77/08/09	88/04/11
					TOT	17	18.41200	374.1300	19.34300	74	3	77/04/12	88/04/11
01052	LEAD	SEDMG/KG	DRY WGT	WATER	K	1	1.400000			1.40	1.40	83/08/19	83/08/19
01055	MANGNESE	MN	UG/L	WATER	K	1	10.00000			10.0	10.0	77/10/11	77/10/11
01092	ZINC	ZN,TOT	UG/L	WATER		6	32.83300	760.9700	27.58600	81	10	77/06/07	88/04/11
					K	6	15.50000	49.50000	7.035600	20	5	83/08/19	88/01/25
					TOT	12	24.16700	450.3300	21.22100	81	5	77/06/07	88/04/11
01093	ZINC	SEDMG/KG	DRY WGT	WATER		1	15.00000			15.00	15.00	83/08/19	83/08/19
01147	SELENIUM	SE,TOT	UG/L	WATER		1	20.00000			20	20	81/05/19	81/05/19

MSPLA2
33 43 44.0 117 56 26.0 2
SOUTH SIDE OF PHASE TWO LAKE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
MILE SQUARE PARK
21CAOCFC 770210 18070201
0999 FEET DEPTH

/TYPA/AMBNT/LAKE

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
01147	SELENIUM	SE,TOT	UG/L	WATER	K	1	2.000000			2	2	80/10/14	80/10/14
01147	SELENIUM	SE,TOT	UG/L	WATER	TOT	2	11.00000	162.0000	12.72800	20	2	80/10/14	81/05/19
31507	TOT COLI	MPN COMP	/100ML	WATER		1	2800.000			2800	2800	79/05/06	79/05/06
32730	PHENOLS	TOTAL	UG/L	WATER	K	1	50.00000			50	50	77/07/12	77/07/12
46570	CAL HARD	CA MG	MG/L	WATER	$	16	191.4500	11422.00	106.8700	557	92	76/11/11	86/10/16
70301	DISS SOL	SUM	MG/L	WATER		15	328.6700	5201.300	72.12000	431	210	76/11/11	85/11/19
71850	NITRATE	TOT-NO3	MG/L	WATER		42	4.227900	15.00500	3.873600	17.0	.1	76/11/11	86/03/31
					K	26	.5511500	.6694700	.8182100	4.4	.1	78/05/09	88/07/18
					TOT	68	2.822100	12.67200	3.559800	17.0	.1	76/11/11	88/07/18
71885	IRON	FE	UG/L	WATER		1	40.00000			40.00	40.00	77/10/11	77/10/11
71900	MERCURY	HG,TOTAL	UG/L	WATER	K	3	3.000000	4.000000	2.000000	5.0	1.0	80/10/14	84/11/07
74041	WQF	SAMPLE	UPDATED	WATER		102	881510.0	1784E+05	13357.00	900412	860717	85/10/23	90/04/03
80101	CARBON	DRY WGT	MG/KG	WATER		5	1413.200	955870.0	977.6900	2100.0	5.0	83/11/10	86/10/16
82007	% SAND	IN SED	DRY WGT	WATER		1	97.00000			97.00	97.00	84/05/10	84/05/10
82008	SEDIMENT	PARTSIZE	SILT	WATER		1	.0000000			.00	.00	84/05/10	84/05/10
82009	SEDIMENT	PARTSIZE	CLAY	WATER		1	3.000000			3.00	3.00	84/05/10	84/05/10

BCEC02
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AT EDINGER
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140792
BOLSA CHICA CHANNEL
21CAOCFC 18070201
0999 FEET DEPTH

/TYPA/AMBNT/STREAM

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER		7	21.35700	3.226800	1.796300	24.0	19.0	73/04/06	73/10/02
00011	WATER	TEMP	FAHN	WATER	$	7	70.44300	10.46600	3.235200	75.2	66.2	73/04/06	73/10/02
00061	STREAM	FLOW,	INST-CFS	WATER	J	1	2.000000			2	2	73/08/20	73/08/20
00095	CNDUCTVY	AT 25C	MICROMHO	WATER		7	37153.00	2671E+05	16346.00	51170	1600	73/04/06	73/10/02
00403	PH	LAB	SU	WATER		7	8.185700	.0881350	.2968800	8.6	7.8	73/04/06	73/10/02
00440	HCO3 ION	HCO3	MG/L	WATER		2	155.0000	8.000000	2.828400	157	153	73/05/08	73/06/04
00445	CO3 ION	CO3	MG/L	WATER		2	.0000000	.0000000	.0000000	0	0	73/05/08	73/06/04
00530	RESIDUE	TOT NFLT	MG/L	WATER		4	24.50000	75.66700	8.698700	37	17	73/07/09	73/10/02
00610	NH3+NH4-	N TOTAL	MG/L	WATER		1	.0000000			.000	.000	73/06/04	73/06/04
					K	6	.1000000	.0000000	.0000000	.100	.100	73/04/06	73/10/02
					TOT	7	.0857140	.0014286	.0377970	.100	.000	73/04/06	73/10/02
00612	UN-IONZD	NH3-N	MG/L	WATER	$	7	.0069563	.0000307	.0055441	.017	.000	73/04/06	73/10/02
00619	UN-IONZD	NH3-NH3	MG/L	WATER	$	7	.0084581	.0000454	.0067410	.021	.000	73/04/06	73/10/02
00625	TOT KJEL	N	MG/L	WATER		5	1.280000	.8820000	.9391500	2.900	.500	73/06/04	73/10/02
					K	1	.1000000			.100	.100	73/05/08	73/05/08
					TOT	6	1.083300	.9376700	.9683300	2.900	.100	73/05/08	73/10/02
00650	T PO4	PO4	MG/L	WATER		7	.2714300	.0170810	.1307000	.41	.10	73/04/06	73/10/02
00900	TOT HARD	CACO3	MG/L	WATER		1	6270.000			6270	6270	73/06/04	73/06/04
00915	CALCIUM	CA,DISS	MG/L	WATER		2	397.5000	24.50000	4.949800	401.0	394.0	73/05/08	73/06/04
00925	MGNSIUM	MG,DISS	MG/L	WATER		2	1253.000	2048.000	45.25500	1285.0	1221.0	73/05/08	73/06/04
00930	SODIUM	NA,DISS	MG/L	WATER		2	10545.00	26448.00	162.6300	10660.00	10430.00	73/05/08	73/06/04
00935	PTSSIUM	K,DISS	MG/L	WATER		2	432.0000	9248.000	96.16700	500.00	364.00	73/05/08	73/06/04
00940	CHLORIDE	TOTAL	MG/L	WATER		2	18745.00	344320.0	586.7900	19160	18330	73/05/08	73/06/04
00945	SULFATE	SO4-TOT	MG/L	WATER		2	2627.000	450.0000	21.21300	2642	2612	73/05/08	73/06/04
00950	FLUORIDE	F,DISS	MG/L	WATER		2	1.300000	.0200020	.1414300	1.40	1.20	73/05/08	73/06/04
00955	SILICA	DISOLVED	MG/L	WATER		6	1.500000	.7000000	.8366600	3.0	1.0	73/04/06	73/10/02
					K	1	1.000000			1.0	1.0	73/05/08	73/05/08
					TOT	7	1.428600	.6190500	.7868000	3.0	1.0	73/04/06	73/10/02
01002	ARSENIC	AS,TOT	UG/L	WATER		1	1.000000			1	1	73/04/06	73/04/06
01020	BORON	B,DISS	UG/L	WATER		2	4385.000	8448.000	91.91300	4450	4320	73/05/08	73/06/04
01027	CADMIUM	CD,TOT	UG/L	WATER		1	170.0000			170	170	73/04/06	73/04/06
01051	LEAD	PB,TOT	UG/L	WATER		4	248.2500	107330.0	327.6100	700	5	73/04/06	73/10/02
01092	ZINC	ZN,TOT	UG/L	WATER		1	110.0000			110	110	73/04/06	73/04/06
01147	SELENIUM	SE,TOT	UG/L	WATER		1	5.000000			5	5	73/04/06	73/04/06
46570	CAL HARD	CA MG	MG/L	WATER	$	2	6152.400	30272.00	173.9900	6275	6029	73/05/08	73/06/04
70301	DISS SOL	SUM	MG/L	WATER		2	34085.00	509950.0	714.1100	34590	33580	73/05/08	73/06/04
71850	NITRATE	TOT-NO3	MG/L	WATER		4	1.400000	6.100000	2.469800	5.1	.0	73/04/06	73/08/20
					K	3	.1000000	.0000000	.0000000	.1	.1	73/05/08	73/10/02
					TOT	7	.8428600	3.532900	1.879600	5.1	.0	73/04/06	73/10/02

BCEC02
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AT EDINGER
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140792
BOLSA CHICA CHANNEL
21CAOCFC 18070201
0999 FEET DEPTH

/TYPA/AMBNT/STREAM

PARAMETER		MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
71900 MERCURY HG,TOTAL	UG/L	WATER	K	1	1.000000			1.0	1.0	73/04/06	73/04/06

WMCC04
33 43 49.0 118 01 54.0 2
AT HAZARD/BEACH BLVD
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
WESTMINSTER CHANNEL
21CAOCFC 770210 18070201
0000 FEET DEPTH

/TYPA/AMBNT/STREAM

PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010 WATER TEMP CENT	WATER		137	18.10100	20.57400	4.535800	28.5	8.0	76/11/09	92/03/23
00011 WATER TEMP FAHN	WATER	$	137	64.58000	66.80100	8.173200	83.3	46.4	76/11/09	92/03/23
00061 STREAM FLOW, INST-CFS	WATER		7	88.21400	50544.00	224.8200	598	.5	82/01/12	92/02/12
		J	95	42.71700	12882.00	113.5000	750	0	76/11/09	88/03/25
		TOT	102	45.84000	15125.00	122.9800	750	0	76/11/09	92/02/12
00076 TURB TRBIDMTR HACH FTU	WATER		152	20.41400	1471.100	38.35500	260.0	.2	76/11/09	92/03/27
00093 SOLIDS FLOAT MG/L	WATER		2	10150.00	405010.0	636.4000	10600.0	9700.0	81/10/12	82/09/20
00094 CNDUCTVY FIELD MICROMHO	WATER		120	3896.100	65143000	8071.100	36000	12	77/01/25	92/03/23
00095 CNDUCTVY AT 25C MICROMHO	WATER		152	4925.500	77225000	8787.800	38210	86	76/11/09	92/03/27
00116 INTNSVE SURVEY IDENT	WATER		58	730600.0	.0000000	.0000000	730601	730601	76/11/12	92/03/27
00300 DO MG/L	WATER		116	9.613900	11.73800	3.426100	19.2	2.0	76/11/09	92/03/23
		K	1	15.00000			15.0	15.0	83/05/10	83/05/10
		L	12	15.41700	2.083400	1.443400	20.0	15.0	77/01/06	89/07/11
		TOT	129	10.19600	13.76800	3.710500	20.0	2.0	76/11/09	92/03/23
00301 DO SATUR PERCENT	WATER	$	127	106.7200	1742.500	41.74300	238.1	22.2	76/11/09	92/03/23
00310 BOD 5 DAY MG/L	WATER		4	12.50000	159.0000	12.61000	31.0	4.0	78/04/11	79/10/09
00335 COD LOWLEVEL MG/L	WATER		41	68.96100	3358.900	57.95600	290.0	4.0	77/01/25	79/10/09
00400 PH SU	WATER		122	7.914800	.4906400	.7004600	9.50	5.60	76/11/09	92/03/23
00403 PH LAB SU	WATER		152	7.766800	.3377200	.5811400	9.3	6.3	76/11/09	92/03/27
00405 CO2 MG/L	WATER		2	3.100000	19.22000	4.384100	6.2	.0	77/07/12	83/11/08
00440 HCO3 ION HCO3 MG/L	WATER		2	225.0000	26450.00	162.6400	340	110	77/07/12	83/11/08
00445 CO3 ION CO3 MG/L	WATER		1	11.00000			11	11	77/07/12	77/07/12
00530 RESIDUE TOT NFLT MG/L	WATER		136	89.31500	19385.00	139.2300	940	.4	76/11/09	92/03/26
		K	15	5.000000	.0000000	.0000000	5	5	79/01/18	92/03/27
		TOT	151	80.94000	18087.00	134.4900	940	.4	76/11/09	92/03/27
00535 RESIDUE VOL NFLT MG/L	WATER		123	27.91600	1568.900	39.61000	300	.2	77/04/12	92/03/26
		K	19	4.526300	2.013200	1.418900	5	.5	79/01/18	92/03/27
		TOT	142	24.78600	1421.600	37.70400	300	.2	77/04/12	92/03/27
00550 OIL-GRSE TOT-SXLT MG/L	WATER		24	20.73800	5027.300	70.90300	353.0	.1	76/11/12	87/12/16
		K	3	3.366700	8.003400	2.829000	5.0	.1	81/05/19	86/11/18
		TOT	27	18.80800	4478.800	66.92400	353.0	.1	76/11/12	87/12/16
00610 NH3+NH4- N TOTAL MG/L	WATER		100	.4396000	.1809100	.4253400	2.900	.100	76/11/09	92/03/26
		K	52	.1375000	.0151840	.1232200	.550	.050	77/05/24	92/03/27
		TOT	152	.3362500	.1444200	.3800200	2.900	.050	76/11/09	92/03/27
00612 UN-IONZD NH3-N MG/L	WATER	$	78	.0096632	.0002641	.0162520	.088	.00001	76/11/09	90/01/24
00619 UN-IONZD NH3-NH3 MG/L	WATER	$	78	.0117490	.0003904	.0197610	.107	.00001	76/11/09	90/01/24
00625 TOT KJEL N MG/L	WATER		143	2.072600	2.057800	1.434500	9.400	.100	76/11/09	92/03/27
		K	9	.3777800	.0344450	.1855900	.500	.100	79/10/09	92/02/13
		TOT	152	1.972200	2.098000	1.448500	9.400	.100	76/11/09	92/03/27

WMCC04
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AT HAZARD/BEACH BLVD
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
WESTMINSTER CHANNEL
21CAOCFC 770210 18070201
0000 FEET DEPTH

/TYPA/AMBNT/STREAM

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00650	T PO4	PO4	MG/L	WATER		135	1.661000	21.57000	4.644400	42.00	.06	76/11/09	92/03/27
					K	17	.3170600	.0508470	.2254900	.50	.03	77/04/12	90/01/24
					TOT	152	1.510700	19.32800	4.396300	42.00	.03	76/11/09	92/03/27
00668	PHOS MUD	DRY WGT	MG/KG-P	WATER		6	700.3900	1019300	1009.600	2100.0	.5	80/10/14	86/10/14
00680	T ORG C	C	MG/L	WATER		3	16.53300	.6536900	.8085100	17.0	15.6	83/11/08	85/10/15
					K	1	3.000000			3.0	3.0	86/10/13	86/10/13
					TOT	4	13.15000	46.22300	6.798800	17.0	3.0	83/11/08	86/10/13
00721	CYANIDE	SEDMG/KG	DRY WGT	WATER	K	1	.0300000			.03	.03	80/10/14	80/10/14
00747	SULFIDE	IN SED.	MG/KG	WATER		1	27.00000			27.00	27.00	82/11/09	82/11/09
					K	4	1.025000	.4825000	.6946200	1.90	.20	80/10/14	85/10/15
					TOT	5	6.220000	135.3000	11.63200	27.00	.20	80/10/14	85/10/15
00900	TOT HARD	CACO3	MG/L	WATER		16	302.8100	455910.0	675.2100	2610	22	77/07/12	92/03/27
00915	CALCIUM	CA,DISS	MG/L	WATER		2	202.5000	6612.500	81.31700	260.0	145.0	77/07/12	83/11/08
00925	MGNSIUM	MG,DISS	MG/L	WATER		2	339.0000	39762.00	199.4100	480.0	198.0	77/07/12	83/11/08
00930	SODIUM	NA,DISS	MG/L	WATER		2	2825.000	2761300	1661.700	4000.00	1650.00	77/07/12	83/11/08
00935	PTSSIUM	K,DISS	MG/L	WATER		2	102.5000	1512.500	38.89100	130.00	75.00	77/07/12	83/11/08
00940	CHLORIDE	TOTAL	MG/L	WATER		2	4936.000	8520200	2918.900	7000	2872	77/07/12	83/11/08
00945	SULFATE	SO4-TOT	MG/L	WATER		2	954.0000	239430.0	489.3200	1300	608	77/07/12	83/11/08
00950	FLUORIDE	F,DISS	MG/L	WATER		2	.5950000	.3280500	.5727600	1.00	.19	77/07/12	83/11/08
00955	SILICA	DISOLVED	MG/L	WATER		65	5.786100	20.95100	4.577200	19.0	.3	76/11/09	83/11/08
					K	3	.7666700	.1633300	.4041500	1.0	.3	79/04/10	80/03/03
					TOT	68	5.564700	21.09600	4.593100	19.0	.3	76/11/09	83/11/08
01002	ARSENIC	AS,TOT	UG/L	WATER		6	4.800000	31.20000	5.585700	16	1	79/10/09	86/10/13
					K	10	10.50000	91.83300	9.583000	33	2	77/01/25	87/05/20
					TOT	16	8.362500	73.62300	8.580400	33	1	77/01/25	87/05/20
01003	ARSENIC	SEDMG/KG	DRY WGT	WATER		13	4.541500	45.39800	6.737800	25.00	.46	78/11/07	89/01/18
01020	BORON	B,DISS	UG/L	WATER		2	1280.000	204800.0	452.5500	1600	960	77/07/12	83/11/08
01027	CADMIUM	CD,TOT	UG/L	WATER		30	5.766700	57.70200	7.596200	30	1	76/11/09	82/11/08
					K	27	7.740700	53.20000	7.293800	20	1	77/06/07	92/03/27
					TOT	57	6.701800	55.57000	7.454600	30	1	76/11/09	92/03/27
01028	CD MUD	DRY WGT	MG/KG-CD	WATER		10	.9800000	.8579500	.9262600	2.80	.23	78/11/07	85/10/15
					K	4	.5350000	.0187000	.1367500	.73	.41	80/05/13	89/01/18
					TOT	14	.8528600	.6418100	.8011300	2.80	.23	78/11/07	89/01/18
01029	CHROMIUM	SEDMG/KG	DRY WGT	WATER		14	13.98300	90.33100	9.504300	31.00	1.36	78/11/07	89/01/18
01034	CHROMIUM	CR,TOT	UG/L	WATER		47	13.70900	174.8500	13.22300	70	2	76/11/09	92/02/12
					K	44	11.27300	121.4100	11.01900	50	1	77/07/12	92/03/27
					TOT	91	12.53100	148.8800	12.20200	70	1	76/11/09	92/03/27
01042	COPPER	CU,TOT	UG/L	WATER		114	42.56100	4794.100	69.23900	500	2	77/01/25	92/03/27
					K	11	18.63600	269.6600	16.42100	50	3	77/09/13	92/03/21

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01042 COPPER CU,TOT UG/L	WATER	TOT	125	40.45600	4436.800	66.61000	500	2	77/01/25	92/03/27
01043 COPPER SEDMG/KG DRY WGT	WATER		15	72.00700	10933.00	104.5600	410.00	3.60	78/11/07	89/01/18
01045 IRON FE,TOT UG/L	WATER		3	320.0000	9300.000	96.43700	390	210	83/11/07	86/10/13
01051 LEAD PB,TOT UG/L	WATER		103	98.92200	10450.00	102.2200	540	5	76/11/09	92/03/27
		K	29	16.72400	256.2800	16.00900	70	2	77/08/17	92/03/21
		TOT	132	80.86400	9358.100	96.73700	540	2	76/11/09	92/03/27
01052 LEAD SEDMG/KG DRY WGT	WATER		14	66.95000	7382.400	85.92100	320.00	8.70	78/11/07	86/10/14
01067 NICKEL NI,TOTAL UG/L	WATER		1	10.00000			10	10	92/02/12	92/02/12
		K	13	21.53900	230.7700	15.19100	40	10	92/02/05	92/03/27
		TOT	14	20.71400	222.5300	14.91700	40	10	92/02/05	92/03/27
01077 SILVER AG,TOT UG/L	WATER		3	41.00000	1116.000	33.40700	71.0	5.0	92/02/11	92/02/13
		K	11	5.636400	17.45500	4.177900	10.0	2.0	92/02/05	92/03/27
		TOT	14	13.21400	411.8700	20.29500	71.0	2.0	92/02/05	92/03/27
01092 ZINC ZN,TOT UG/L	WATER		130	119.1400	28711.00	169.4400	1430	3	76/11/09	92/03/27
		K	2	15.00000	50.00000	7.071100	20	10	83/07/12	87/02/10
		TOT	132	117.5600	28436.00	168.6300	1430	3	76/11/09	92/03/27
01093 ZINC SEDMG/KG DRY WGT	WATER		14	146.0000	23622.00	153.7000	470.00	18.00	78/11/07	89/01/18
01143 SILICON SILICATE UG/L SI	WATER	K	1	.1000000			.1	.1	83/05/09	83/05/09
01147 SELENIUM SE,TOT UG/L	WATER		6	5.066700	55.22700	7.431500	20	.4	77/01/25	86/10/13
		K	9	13.00000	266.0000	16.31000	54	2	78/04/11	87/05/20
		TOT	15	9.826700	187.9100	13.70800	54	.4	77/01/25	87/05/20
01148 SELENIUM SEDMG/KG DRY WGT	WATER		4	.3957500	.1747600	.4180400	1.00	.09	79/05/09	86/10/14
		K	8	.5400000	.3740000	.6115600	1.90	.05	78/11/07	85/10/15
		TOT	12	.4919200	.2907100	.5391700	1.90	.05	78/11/07	86/10/14
01170 FE MUD DRY WGT MG/KG-FE	WATER		3	14667.00	65334000	8082.900	22000.00	6000.00	83/11/08	86/10/14
01501 ALPHA TOTAL PC/L	WATER		2	.1950000	.0004500	.0212140	.2	.2	79/01/17	89/03/08
03501 BETA TOTAL PC/L	WATER		2	.1250000	.0000500	.0070719	.1	.1	79/01/17	89/03/08
31507 TOT COLI MPN COMP /100ML	WATER		82	140630.0	1466E+08	382890.0	2400000	75	76/11/09	82/09/21
		L	2	2400000	.0000000	.0000000	2400000	2400000	80/03/03	81/10/02
		TOT	84	194420.0	2631E+08	512980.0	2400000	75	76/11/09	82/09/21
31615 FEC COLI MPNECMED /100ML	WATER		1	21000.00			21000	21000	77/10/11	77/10/11
32730 PHENOLS TOTAL UG/L	WATER	K	12	35.83300	317.4300	17.81700	50	10	77/01/25	82/11/09
32860 INVALID PAR NUMBER	WATER		1	.1200000			.1200000	.1200000	78/04/11	78/04/11
34257 BETA BHC SEDUG/KG DRY WGT	WATER	K	3	41.66700	2608.300	51.07200	100.000	5.000	82/11/09	85/10/15
34259 DELTABHC TOTUG/L	WATER	K	4	2.527500	24.81700	4.981700	10.000	.010	82/11/09	86/10/14
34262 DELTABHC SEDUG/KG DRY WGT	WATER	K	3	41.66700	2608.300	51.07200	100.000	5.000	82/11/09	85/10/15
34337 DIETHYLP HTHALATE DISSUG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
34338 DIETHYLP HTHALATE SUSPUG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
34351 ENDSULSF TOTUG/L	WATER	K	4	2.562500	24.58600	4.958400	10.000	.050	82/11/09	86/10/14

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34354	ENDSULSF SEDUG/KG DRY WGT	WATER	K	3	110.0000	27100.00	164.6200	300.000	10.000	82/11/09	85/10/15
34356	B-ENDO SULFAN TOTWUG/L	WATER	K	4	2.527500	24.81700	4.981700	10.000	.010	82/11/09	86/10/14
34359	BENDOSUL SEDUG/KG DRY WGT	WATER	K	3	41.66700	2608.300	51.07200	100.000	5.000	82/11/09	85/10/15
34361	A-ENDO SULFAN TOTWUG/L	WATER	K	4	2.527500	24.81700	4.981700	10.000	.010	82/11/09	86/10/14
34364	AENDOSUL SEDUG/KG DRY WGT	WATER	K	3	41.66700	2608.300	51.07200	100.000	5.000	82/11/09	85/10/15
34671	PCB 1016 TOTWUG/L	WATER	K	6	.8833300	.0816670	.2857800	1.000	.300	81/11/10	86/10/14
38260	MBAS MG/L	WATER		11	.2790900	.1004100	.3168700	1.10	.07	78/04/11	86/10/14
			K	3	.0700000	.0027000	.0519620	.10	.01	79/05/09	83/05/09
			TOT	14	.2342900	.0855800	.2925400	1.10	.01	78/04/11	86/10/14
39034	PERTHANE WHL SMPL UG/L	WATER	K	12	2.375000	8.233000	2.869300	10.000	.500	79/05/03	86/10/14
39045	2,4,5-TP WTR SMPL UG/L	WATER	K	1	5.000000			5.000	5.000	79/05/03	79/05/03
39046	SIMAZINE MUD UG/GK	WATER	K	8	18.75000	205.3600	14.33000	50.00	5.00	79/05/03	85/10/15
39055	SIMAZINE WH.WATER (UG/L)	WATER	K	7	.9285700	.0357150	.1889800	1	.5	79/05/09	86/10/14
39076	ALPHABHC SEDUG/KG DRY WGT	WATER	K	3	41.66700	2608.300	51.07200	100.000	5.000	82/11/09	85/10/15
39310	P,P'DDD TOT UG/L	WATER	K	1	1.000000			1.000	1.000	81/11/10	81/11/10
39330	ALDRIN TOT UG/L	WATER	K	17	1.141500	2.305300	1.518300	5.000	.005	77/01/25	86/10/14
39333	ALDRIN SEDUG/KG DRY WGT	WATER	K	13	20.80800	618.4800	24.86900	100.00	.50	78/11/07	85/10/15
39337	ALPHABHC TOTUG/L	WATER	K	3	.0350000	.0006750	.0259810	.050	.005	83/11/08	86/10/14
39338	BETA BHC TOTUG/L	WATER	K	3	.0366670	.0005333	.0230940	.050	.010	83/11/08	86/10/14
39340	GAMMABHC LINDANE TOT.UG/L	WATER	K	15	1.290000	2.433700	1.560000	5.000	.050	77/01/25	83/11/08
39343	GBHC-MUD LINDANE DRYUG/KG	WATER	K	12	14.20800	57.06600	7.554200	20.00	.50	78/11/07	83/11/08
39350	CHLRDANE TECH&MET TOT UG/L	WATER	K	17	1.176500	2.230700	1.493600	5.000	.100	77/01/25	86/10/14
39351	CDANEDRY TECH&MET MUDUG/KG	WATER		2	169.5000	20201.00	142.1300	270.00	69.00	80/05/14	80/05/14
			K	11	59.59100	21406.00	146.3100	500.00	.50	78/11/07	85/10/15
			TOT	13	76.50000	21226.00	145.6900	500.00	.50	78/11/07	85/10/15
39360	DDD WHL SMPL UG/L	WATER	K	17	1.141800	2.304600	1.518100	5.000	.010	77/01/25	86/10/14
39363	DDD MUD UG/KG	WATER	K	13	20.80800	618.4800	24.86900	100.00	.50	78/11/07	85/10/15
39365	DDE WHL SMPL UG/L	WATER	K	17	1.159400	2.270800	1.506900	5.000	.010	77/01/25	86/10/14
39368	DDE MUD UG/KG	WATER	K	13	20.80800	618.4800	24.86900	100.00	.50	78/11/07	85/10/15
39370	DDT WHL SMPL UG/L	WATER	K	17	1.148200	2.289800	1.513200	5.000	.020	77/01/25	86/10/14
39373	DDT MUD UG/KG	WATER	K	13	36.57700	6311.100	79.44200	300.00	.50	78/11/07	85/10/15
39380	DIELDRIN TOTUG/L	WATER	K	17	1.141800	2.304600	1.518100	5.000	.010	77/01/25	86/10/14
39381	DIELDRIN DISUG/L	WATER	K	4	16.25000	56.25000	7.500000	20.000	5.000	79/05/09	80/05/14
39383	DIELDRIN SEDUG/KG DRY WGT	WATER	K	13	20.80800	618.4800	24.86900	100.00	.50	78/11/07	85/10/15
39390	ENDRIN TOT UG/L	WATER	K	17	1.147700	2.291200	1.513700	5.000	.010	77/01/25	86/10/14
39393	ENDRIN SEDUG/KG DRY WGT	WATER	K	12	31.25000	2855.100	53.43300	200.00	5.00	79/05/09	85/10/15
39400	TOXAPHEN TOTUG/L	WATER	K	17	1.282400	2.082800	1.443200	5.000	.100	77/01/25	86/10/14
39403	TOXAPHEN SEDUG/KG DRY WGT	WATER	K	12	271.2900	739070.0	859.6900	3000.00	.50	78/11/07	85/10/15
39410	HEPTCHLR TOTUG/L	WATER	K	17	1.141800	2.304600	1.518100	5.000	.010	77/01/25	86/10/14

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39413	HEPTCHLR	SEDUG/KG	DRY WGT	WATER	K	13	20.80800	618.4800	24.86900	100.00	.50	78/11/07	85/10/15
39420	HPCHLREP		TOTUG/L	WATER	K	17	1.141800	2.304600	1.518100	5.000	.010	77/01/25	86/10/14
39423	HPCHLREP	SEDUG/KG	DRY WGT	WATER	K	13	20.80800	618.4800	24.86900	100.00	.50	78/11/07	85/10/15
39480	MTHXYCLR	WHL SMPL	UG/L	WATER	K	14	1.471400	2.297600	1.515800	5.000	.300	79/05/03	86/10/14
39481	MTHXYCLR	MUD DRY	UG/KG	WATER	K	8	78.75000	29013.00	170.3300	500.00	10.00	79/10/09	85/10/15
39488	PCB-1221		TOTUG/L	WATER	K	6	.8833300	.0816670	.2857800	1.000	.300	81/11/10	86/10/14
39491	PCB-1221	SEDUG/KG	DRY WGT	WATER	K	3	1040.000	2882800	1697.900	3000.00	20.00	82/06/02	85/10/15
39492	PCB-1232		TOTUG/L	WATER	K	17	1.429400	1.834700	1.354500	5.000	.300	77/01/25	86/10/14
39495	PCB-1232	SEDUG/KG	DRY WGT	WATER	K	13	251.1900	682730.0	826.2800	3000.00	.50	78/11/07	85/10/15
39496	PCB-1242		TOTUG/L	WATER	K	17	1.429400	1.834700	1.354500	5.000	.300	77/01/25	86/10/14
39499	PCB-1242	SEDUG/KG	DRY WGT	WATER	K	13	251.1900	682730.0	826.2800	3000.00	.50	78/11/07	85/10/15
39500	PCB-1248		TOTUG/L	WATER	K	6	.8833300	.0816670	.2857800	1.000	.300	81/11/10	86/10/14
39503	PCB-1248	SEDUG/KG	DRY WGT	WATER	K	3	1040.000	2882800	1697.900	3000.00	20.00	82/06/02	85/10/15
39504	PCB-1254		TOTUG/L	WATER		1	1.300000			1.300	1.300	79/10/09	79/10/09
					K	16	1.456300	1.944000	1.394300	5.000	.300	77/01/25	86/10/14
					TOT	17	1.447100	1.823900	1.350500	5.000	.300	77/01/25	86/10/14
39507	PCB-1254	SEDUG/KG	DRY WGT	WATER	K	12	272.0800	738610.0	859.4200	3000.00	5.00	79/05/09	85/10/15
39508	PCB-1260		TOTUG/L	WATER	K	17	1.429400	1.834700	1.354500	5.000	.300	77/01/25	86/10/14
39511	PCB-1260	SEDUG/KG	DRY WGT	WATER	K	13	251.1900	682730.0	826.2800	3000.00	.50	78/11/07	85/10/15
39514	PCB-1016	SEDUG/KG	DRY WGT	WATER	K	2	1550.000	4205000	2050.600	3000.00	100.00	83/11/08	85/10/15
39530	MALATHN	WHL SMPL	UG/L	WATER		1	.5000000			.500	.500	77/01/25	77/01/25
					K	11	2.545500	8.672700	2.945000	10.000	1.000	79/05/03	86/10/14
					TOT	12	2.375000	8.233000	2.869300	10.000	.500	77/01/25	86/10/14
39531	MALATHN	MUD	UG/KG	WATER	K	10	123.5000	95556.00	309.1200	1000.00	5.00	79/05/09	85/10/15
39540	PARATHN	WHL SMPL	UG/L	WATER	K	11	2.545500	8.672700	2.945000	10.000	1.000	79/05/03	86/10/14
39541	PARATHN	MUD	UG/KG	WATER	K	10	123.5000	95556.00	309.1200	1000.00	5.00	79/05/09	85/10/15
39730	2,4-D	WHL SMPL	UG/L	WATER	K	6	6.000000	21.90000	4.679800	10.000	.500	81/11/10	86/10/14
39731	2,4-D	MUD	UG/KG	WATER	K	5	161.0000	37605.00	193.9200	500.00	5.00	81/11/10	85/10/15
39760	SILVEX	WHL SMPL	UG/L	WATER	K	6	5.200000	27.75600	5.268400	10.000	.100	81/11/10	86/10/14
39761	SILVEX	MUD	UG/KG	WATER	K	5	80.20000	1960.200	44.27400	100.00	1.00	81/11/10	85/10/15
39780	DICOFOL	WHL SMPL	UG/L	WATER	K	12	1.441700	2.917200	1.708000	5.000	.100	77/01/25	80/10/14
39782	LINDANE	WHL SMPL	UG/L	WATER	K	15	1.340700	2.360300	1.536300	5.000	.010	79/05/03	86/10/14
39783	LINDANE	MUD DRY	UG/KG	WATER	K	12	22.50000	634.0900	25.18100	100.00	5.00	79/05/09	85/10/15
46570	CAL HARD	CA MG	MG/L	WATER	$	2	1901.700	1049000	1024.200	2626	1177	77/07/12	83/11/08
70301	DISS SOL	SUM	MG/L	WATER		2	9810.500	35104000	5924.900	14000	5621	77/07/12	83/11/08
71850	NITRATE	TOT-NO3	MG/L	WATER		138	10.03400	86.31900	9.290800	54.1	.4	76/11/09	92/03/27
					K	15	.9300000	2.005200	1.416000	4.4	.2	77/05/24	90/05/22
					TOT	153	9.141600	85.36300	9.239200	54.1	.2	76/11/09	92/03/27
71885	IRON	FE	UG/L	WATER		2	640.0000	20000.00	141.4200	740.00	540.00	77/01/25	77/07/12

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71900 MERCURY HG,TOTAL UG/L	WATER		5	5.680000	35.09700	5.924300	15.1	1.3	78/04/11	82/06/01
		K	10	.9100000	.6854500	.8279200	3.0	.2	77/01/25	86/10/13
		TOT	15	2.500000	15.88600	3.985700	15.1	.2	77/01/25	86/10/13
71921 MERCURY SEDMG/KG DRY WGT	WATER		7	.4345700	.9164300	.9573100	2.6	.01	78/11/07	83/11/08
		K	7	.1600000	.0153330	.1238300	.4	.02	80/05/13	89/01/18
		TOT	14	.2972900	.4503400	.6710800	2.6	.01	78/11/07	89/01/18
74041 WQF SAMPLE UPDATED	WATER		75	893360.0	3813E+05	19528.00	920708	860717	77/07/12	92/03/27
80101 CARBON DRY WGT MG/KG	WATER		3	15643.00	66732000	8169.000	25000.0	9930.0	83/11/08	86/10/14
81886 PERTHANE SED DRY WGTUG/KG	WATER	K	4	160.0000	52800.00	229.7800	500.000	20.000	81/11/10	85/10/15
82007 % SAND IN SED DRY WGT	WATER		4	59.05000	1348.700	36.72400	82.00	4.20	82/06/02	85/10/15
82008 SEDIMENT PARTSIZE SILT	WATER		4	33.90000	1433.800	37.86500	89.60	5.00	82/06/02	85/10/15
82009 SEDIMENT PARTSIZE CLAY	WATER		4	4.050000	4.943300	2.223400	6.20	1.00	82/06/02	85/10/15

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PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00003	VSAMPLOC	DEPTH	FEET	WATER		1	7.000000			7	7	78/11/08	78/11/08
00008	LAB	IDENT.	NUMBER	WATER		1	86.60000			87	87	82/06/03	82/06/03
00009	XSAMPLOC	FT FROM	LF BANK	WATER		1	6.200000			6.2	6.2	82/06/03	82/06/03
00010	WATER	TEMP	CENT	BOTTOM		1	19.30000			19.3	19.3	91/08/13	91/08/13
				WATER		399	18.07300	8.392900	2.897100	24.9	1.8	76/11/22	91/08/13
00011	WATER	TEMP	FAHN	BOTTOM	$	1	66.74000			66.7	66.7	91/08/13	91/08/13
				WATER	$	399	64.53100	27.17600	5.213100	76.8	35.2	76/11/22	91/08/13
00035	WIND	VELOCITY	MPH	WATER		69	3.317400	10.96900	3.311900	15.0	.0	79/02/15	91/08/13
					K	1	1.000000			1.0	1.0	87/02/11	87/02/11
					TOT	70	3.284300	10.88700	3.299500	15.0	.0	79/02/15	91/08/13
00036	WIND	DIR.FROM	NORTH-0	WATER		56	204.4700	4740.600	68.85200	315	0	79/03/14	91/08/13
00065	STREAM	STAGE	FEET	WATER		99	3.427300	3.012900	1.735800	7.00	.30	76/11/22	88/05/12
00067	TIDE	STAGE	CODE	WATER		99	3283.700	4094100	2023.400	7310	1010	76/11/22	88/05/12
00076	TURB	TRBIDMTR	HACH FTU	WATER		93	1.462400	3.012600	1.735700	13.0	.2	76/11/22	91/08/13
00078	TRANSP	SECCHI	METERS	WATER		27	1.827800	.1760300	.4195600	2.50	1.00	84/08/22	91/08/13
					L	1	2.000000			2.00	2.00	86/04/16	86/04/16
					TOT	28	1.833900	.1705700	.4130000	2.50	1.00	84/08/22	91/08/13
00094	CNDUCTVY	FIELD	MICROMHO	BOTTOM		1	51100.00			51100	51100	91/08/13	91/08/13
				WATER		391	47836.00	21433000	4629.600	56000	3900	77/01/27	91/08/13
00095	CNDUCTVY	AT 25C	MICROMHO	WATER		90	44961.00	38457000	6201.400	70000	26600	76/11/22	91/08/13
00116	INTNSVE	SURVEY	IDENT	WATER		2	730600.0	.0000000	.0000000	730601	730601	78/02/16	79/01/10
00300	DO		MG/L	BOTTOM		1	6.900000			6.9	6.9	91/08/13	91/08/13
				WATER		381	7.571200	1.230000	1.109100	10.0	4.5	76/12/21	91/08/13
					L	1	15.00000			15.0	15.0	76/11/22	76/11/22
					TOT	382	7.590700	1.371300	1.171000	15.0	4.5	76/11/22	91/08/13
00301	DO	SATUR	PERCENT	BOTTOM	$	1	73.40400			73.4	73.4	91/08/13	91/08/13
				WATER	$	380	79.37500	162.8900	12.76300	157.9	48.9	76/11/22	91/08/13
00310	BOD	5 DAY	MG/L	WATER		3	9.000000	76.00000	8.717800	19.0	3.0	78/04/12	79/10/10
					K	1	3.000000			3.0	3.0	79/05/10	79/05/10
					TOT	4	7.500000	59.66700	7.724400	19.0	3.0	78/04/12	79/10/10
00335	COD	LOWLEVEL	MG/L	WATER		20	296.1500	75218.00	274.2600	896.0	18.0	77/06/08	79/06/13
					K	3	1.000000	.0000000	.0000000	1.0	1.0	78/01/12	78/12/13
					TOT	23	257.6500	75290.00	274.3900	896.0	1.0	77/06/08	79/06/13
00394	BOD INH	13DAYTOT	MG/L	WATER	K	1	5.000000			5.0	5.0	79/05/10	79/05/10
00400	PH		SU	BOTTOM		1	7.600000			7.60	7.60	91/08/13	91/08/13
				WATER		387	8.002500	.0996400	.3156600	8.90	7.24	76/11/22	91/08/13
00403	PH	LAB	SU	WATER		93	7.837500	.0585940	.2420600	8.3	6.9	76/11/22	91/08/13
00530	RESIDUE	TOT NFLT	MG/L	WATER		81	45.11900	12015.00	109.6100	760	.8	76/11/22	91/08/13
					K	12	4.666700	1.333400	1.154700	5	1	85/03/13	90/04/12

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00530 RESIDUE TOT NFLT MG/L	WATER	TOT	93	39.89900	10634.00	103.1200	760	.8	76/11/22	91/08/13
00535 RESIDUE VOL NFLT MG/L	WATER		67	21.06700	1382.500	37.18100	240	.2	77/04/13	90/06/21
		K	21	3.357200	4.628600	2.151400	5	.5	81/01/14	91/08/13
		TOT	88	16.84100	1107.500	33.27900	240	.2	77/04/13	91/08/13
00550 OIL-GRSE TOT-SXLT MG/L	WATER		10	8.074000	83.96500	9.163200	27.0	.8	78/04/12	82/11/10
		K	1	.5000000			.5	.5	79/05/10	79/05/10
		TOT	11	7.385500	80.78300	8.988000	27.0	.5	78/04/12	82/11/10
00610 NH3+NH4- N TOTAL MG/L	WATER		60	.5075000	.4581100	.6768400	4.500	.040	76/11/22	91/08/13
		K	32	.1125000	.0050001	.0707110	.500	.100	76/12/21	85/05/22
		TOT	92	.3701100	.3345000	.5783600	4.500	.040	76/11/22	91/08/13
00612 UN-IONZD NH3-N MG/L	WATER	$	82	.0147330	.0004334	.0208190	.129	.0010	76/11/22	91/08/13
00619 UN-IONZD NH3-NH3 MG/L	WATER	$	82	.0179140	.0006407	.0253130	.157	.001	76/11/22	91/08/13
00625 TOT KJEL N MG/L	WATER		82	1.009400	1.042600	1.021100	7.200	.130	76/11/22	91/08/13
		K	10	.2100000	.0254450	.1595100	.500	.100	79/03/14	85/10/16
		TOT	92	.9225000	.9931000	.9965400	7.200	.100	76/11/22	91/08/13
00650 T PO4 PO4 MG/L	WATER		74	.2998600	.0503260	.2243300	1.22	.02	76/11/22	90/06/21
		K	19	.2331600	.0407900	.2019700	.50	.03	77/10/12	91/08/13
		TOT	93	.2862400	.0486440	.2205500	1.22	.02	76/11/22	91/08/13
00668 PHOS MUD DRY WGT MG/KG-P	WATER		5	216.2400	76011.00	275.7000	642.0	11.0	78/04/12	83/05/11
00745 SULFIDE TOTAL MG/L	WATER		1	.0000000			.00	.00	83/11/09	83/11/09
00747 SULFIDE IN SED. MG/KG	WATER		2	3.200000	6.480000	2.545600	5.00	1.40	82/11/10	83/05/11
		K	1	1.400000			1.40	1.40	82/06/03	82/06/03
		TOT	3	2.600000	4.320000	2.078500	5.00	1.40	82/06/03	83/05/11
00955 SILICA DISOLVED MG/L	WATER		23	.9826100	1.182400	1.087400	4.5	.1	76/11/22	80/10/15
		K	21	.6666700	1.127300	1.061800	5.0	.1	76/12/21	80/11/13
		TOT	44	.8318200	1.154800	1.074600	5.0	.1	76/11/22	80/11/13
01002 ARSENIC AS,TOT UG/L	WATER		2	27.50000	312.5000	17.67800	40	15	82/06/03	83/05/11
		K	13	7.307700	17.39800	4.171000	16	2	77/07/13	89/01/19
		TOT	15	10.00000	87.71400	9.365600	40	2	77/07/13	89/01/19
01003 ARSENIC SEDMG/KG DRY WGT	WATER		6	4.083300	2.781700	1.667900	6.70	2.50	78/04/12	83/05/11
01019 CD MUD WET WGTM G/KG-CD	WATER		1	.7300000			.73	.73	78/04/12	78/04/12
01027 CADMIUM CD,TOT UG/L	WATER		15	17.60000	466.2600	21.59300	82	1	76/12/21	83/05/11
		K	17	5.235300	30.44100	5.517400	20	1	76/11/22	89/01/19
		TOT	32	11.03100	265.5800	16.29700	82	1	76/11/22	89/01/19
01028 CD MUD DRY WGT MG/KG-CD	WATER		5	.4060000	.0395310	.1988200	.73	.20	78/04/12	83/05/11
		K	1	.1600000			.16	.16	82/06/03	82/06/03
		TOT	6	.3650000	.0417100	.2042300	.73	.16	78/04/12	83/05/11
01029 CHROMIUM SEDMG/KG DRY WGT	WATER		6	9.508300	27.80700	5.273200	17.00	3.85	78/04/12	83/05/11
01034 CHROMIUM CR,TOT UG/L	WATER		30	27.45000	802.8700	28.33500	120	1	77/06/08	87/09/23

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01034 CHROMIUM CR,TOT UG/L	WATER	K	31	12.91300	254.3700	15.94900	60	.3	76/11/22	90/06/21
01034 CHROMIUM CR,TOT UG/L	WATER	TOT	61	20.06200	568.9400	23.85200	120	.3	76/11/22	90/06/21
01039 CU MUD WET WGTM G/KG-CU	WATER		1	8.080000			8.08	8.08	78/04/12	78/04/12
01042 COPPER CU,TOT UG/L	WATER		50	44.56000	1581.000	39.76100	180	2	77/02/09	90/06/21
		K	32	21.34400	291.8500	17.08400	70	6	77/09/14	90/04/12
		TOT	82	35.50000	1197.900	34.61100	180	2	77/02/09	90/06/21
01043 COPPER SEDMG/KG DRY WGT	WATER		6	10.53000	14.62600	3.824500	17.00	6.80	78/04/12	83/05/11
01045 IRON FE,TOT UG/L	WATER		1	210.0000			210	210	86/10/15	86/10/15
01051 LEAD PB,TOT UG/L	WATER		35	12.74300	111.2000	10.54500	50	3	76/12/21	90/04/12
		K	50	17.96000	1463.300	38.25300	200	1	76/11/22	90/06/21
		TOT	85	15.81200	905.2700	30.08800	200	1	76/11/22	90/06/21
01052 LEAD SEDMG/KG DRY WGT	WATER		6	14.71700	20.73800	4.553900	21.00	8.90	78/04/12	83/05/11
01092 ZINC ZN,TOT UG/L	WATER		61	40.98400	1931.800	43.95200	250	6	76/11/22	89/01/19
		K	25	20.16000	783.0600	27.98300	150	5	77/04/13	90/06/21
		TOT	86	34.93000	1675.200	40.92900	250	5	76/11/22	90/06/21
01093 ZINC SEDMG/KG DRY WGT	WATER		6	42.06700	332.6700	18.23900	75.00	28.00	78/04/12	83/05/11
01102 TIN SN,TOT UG/L	WATER	K	2	2565.000	11859000	3443.600	5000	130	79/05/10	86/10/15
01103 TIN MUD DRY WGT MG/KG-SN	WATER		1	18.00000			18.00	18.00	79/05/10	79/05/10
01143 SILICON SILICATE UG/L SI	WATER	K	1	.1000000			.1	.1	83/05/11	83/05/11
01147 SELENIUM SE,TOT UG/L	WATER		3	10.66700	85.33400	9.237600	16	0	78/04/12	86/10/15
		K	12	13.58300	248.9900	15.78000	50	1	77/07/13	89/07/13
		TOT	15	13.00000	209.2900	14.46700	50	0	77/07/13	89/07/13
01148 SELENIUM SEDMG/KG DRY WGT	WATER		1	.4600000			.46	.46	78/04/12	78/04/12
		K	5	.4660000	.3425800	.5853000	1.40	.06	78/11/08	83/05/11
		TOT	6	.4650000	.2740700	.5235200	1.40	.06	78/04/12	83/05/11
01501 ALPHA TOTAL PC/L	WATER		3	.0800000	.0192000	.1385700	.2	0	89/01/19	89/03/23
		K	1	3.000000			3	3	81/05/20	81/05/20
		TOT	4	.8100000	2.144400	1.464400	3	0	81/05/20	89/03/23
01502 ALPHA-T ERROR PC/L	WATER		1	.3000000			.3	.3	81/05/20	81/05/20
03501 BETA TOTAL PC/L	WATER		3	.0173330	.0009013	.0300220	.05	0	89/01/19	89/03/23
		K	1	4.000000			4	4	81/05/20	81/05/20
		TOT	4	1.013000	3.966000	1.991500	4	0	81/05/20	89/03/23
03502 BETA-T ERROR PC/L	WATER		1	1.000000			1	1	81/05/20	81/05/20
09501 RA-226 TOTAL PC/L	WATER	K	1	.5000000			.5	.5	81/05/20	81/05/20
09502 RA-226 ERROR PC/L	WATER		1	.1000000			.1	.1	81/05/20	81/05/20
32730 PHENOLS TOTAL UG/L	WATER	K	11	31.81800	316.3700	17.78700	50	10	77/07/13	82/11/10
34257 BETA BHC SEDUG/KG DRY WGT	WATER	K	1	20.00000			20.000	20.000	82/11/10	82/11/10
34259 DELTABHC TOTUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34262 DELTABHC SEDUG/KG DRY WGT	WATER	K	1	20.00000			20.000	20.000	82/11/10	82/11/10

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34337	DIETHYLP HTHALATE DISSUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34338	DIETHYLP HTHALATE SUSPUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34351	ENDSULSF TOTUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34354	ENDSULSF SEDUG/KG DRY WGT	WATER	K	1	20.00000			20.000	20.000	82/11/10	82/11/10
34356	B-ENDO SULFAN TOTWUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34359	BENDOSUL SEDUG/KG DRY WGT	WATER	K	1	20.00000			20.000	20.000	82/11/10	82/11/10
34361	A-ENDO SULFAN TOTWUG/L	WATER	K	1	1.000000			1.000	1.000	82/11/10	82/11/10
34364	AENDOSUL SEDUG/KG DRY WGT	WATER	K	1	20.00000			20.000	20.000	82/11/10	82/11/10
34671	PCB 1016 TOTWUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
38260	MBAS MG/L	WATER		6	.0816670	.0104170	.1020600	.27	.01	80/05/14	82/11/10
			K	1	.0100000			.01	.01	79/05/10	79/05/10
			TOT	7	.0714290	.0094143	.0970270	.27	.01	79/05/10	82/11/10
39034	PERTHANE WHL SMPL UG/L	WATER	K	6	1.000000	.0000000	.0000000	1.000	1.000	79/05/10	82/11/10
39046	SIMAZINE MUD UG/GK	WATER	K	1	5.000000			5.00	5.00	79/05/10	79/05/10
39055	SIMAZINE WH.WATER (UG/L)	WATER	K	5	2.800000	16.20000	4.024900	10	1	79/05/10	82/11/10
39076	ALPHABHC SEDUG/KG DRY WGT	WATER	K	1	20.00000			20.000	20.000	82/11/10	82/11/10
39330	ALDRIN TOT UG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39333	ALDRIN SEDUG/KG DRY WGT	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39340	GAMMABHC LINDANE TOT.UG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39343	GBHC-MUD LINDANE DRYUG/KG	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39350	CHLRDANE TECH&MET TOT UG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39351	CDANEDRY TECH&MET MUDUG/KG	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39360	DDD WHL SMPL UG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39363	DDD MUD UG/KG	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39365	DDE WHL SMPL UG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39368	DDE MUD UG/KG	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39370	DDT WHL SMPL UG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39373	DDT MUD UG/KG	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39380	DIELDRIN TOTUG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39383	DIELDRIN SEDUG/KG DRY WGT	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39390	ENDRIN TOT UG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39393	ENDRIN SEDUG/KG DRY WGT	WATER	K	2	12.50000	112.5000	10.60700	20.00	5.00	79/05/10	82/11/10
39400	TOXAPHEN TOTUG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39403	TOXAPHEN SEDUG/KG DRY WGT	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39410	HEPTCHLR TOTUG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39413	HEPTCHLR SEDUG/KG DRY WGT	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39420	HPCHLREP TOTUG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39423	HPCHLREP SEDUG/KG DRY WGT	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39480	MTHXYCLR WHL SMPL UG/L	WATER	K	7	1.000000	.0000000	.0000000	1.000	1.000	79/05/10	82/11/10

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SUNSET BAY AT NAVY BUOYS
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
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21CAOCFC 770210 HQ 18070201001 0010.680 OFF
0999 FEET DEPTH

/TYPA/AMBNT/ESTURY

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
39481	MTHXYCLR	MUD DRY	UG/KG	WATER	K	1	20.00000			20.00	20.00	82/11/10	82/11/10
39488	PCB-1221		TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39492	PCB-1232		TOTUG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39495	PCB-1232	SEDUG/KG	DRY WGT	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39496	PCB-1242		TOTUG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39499	PCB-1242	SEDUG/KG	DRY WGT	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39500	PCB-1248		TOTUG/L	WATER	K	3	1.000000	.0000000	.0000000	1.000	1.000	81/11/12	82/11/10
39504	PCB-1254		TOTUG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39507	PCB-1254	SEDUG/KG	DRY WGT	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39508	PCB-1260		TOTUG/L	WATER	K	8	.8875000	.1012500	.3182000	1.000	.100	78/11/08	82/11/10
39511	PCB-1260	SEDUG/KG	DRY WGT	WATER	K	3	8.500000	104.2500	10.21000	20.00	.50	78/11/08	82/11/10
39530	MALATHN	WHL SMPL	UG/L	WATER	K	5	1.000000	.0000000	.0000000	1.000	1.000	79/05/10	82/11/10
39531	MALATHN	MUD	UG/KG	WATER	K	1	5.000000			5.00	5.00	79/05/10	79/05/10
39540	PARATHN	WHL SMPL	UG/L	WATER	K	5	1.000000	.0000000	.0000000	1.000	1.000	79/05/10	82/11/10
39541	PARATHN	MUD	UG/KG	WATER	K	1	5.000000			5.00	5.00	79/05/10	79/05/10
39730	2,4-D	WHL SMPL	UG/L	WATER	K	3	10.00000	.0000000	.0000000	10.000	10.000	81/11/12	82/11/10
39731	2,4-D	MUD	UG/KG	WATER	K	1	100.0000			100.00	100.00	82/11/10	82/11/10
39760	SILVEX	WHL SMPL	UG/L	WATER	K	3	10.00000	.0000000	.0000000	10.000	10.000	81/11/12	82/11/10
39761	SILVEX	MUD	UG/KG	WATER	K	1	100.0000			100.00	100.00	82/11/10	82/11/10
39780	DICOFOL	WHL SMPL	UG/L	WATER	K	5	.8200000	.1620000	.4024900	1.000	.100	78/11/08	80/10/15
39782	LINDANE	WHL SMPL	UG/L	WATER	K	7	1.000000	.0000000	.0000000	1.000	1.000	79/05/10	82/11/10
39783	LINDANE	MUD DRY	UG/KG	WATER	K	2	12.50000	112.5000	10.60700	20.00	5.00	79/05/10	82/11/10
71850	NITRATE	TOT-NO3	MG/L	WATER		53	2.519800	6.943500	2.635100	12.0	.1	76/11/22	90/04/12
					K	40	.3665000	.0233720	.1528800	1.0	.1	78/03/08	91/08/13
					TOT	93	1.593700	5.083400	2.254600	12.0	.1	76/11/22	91/08/13
71885	IRON	FE	UG/L	WATER		2	140.0000	9800.000	98.99500	210.00	70.00	77/07/13	86/10/15
71900	MERCURY	HG,TOTAL	UG/L	WATER		8	2.225000	2.496400	1.580000	4.6	.2	77/07/13	83/05/11
					K	8	.8625000	.2455400	.4955200	2.0	.5	78/11/08	89/07/13
					TOT	16	1.543800	1.774600	1.332200	4.6	.2	77/07/13	89/07/13
71921	MERCURY	SEDMG/KG	DRY WGT	WATER		4	.0640000	.0019547	.0442120	.1	.04	78/11/08	83/05/11
					K	2	.1300000	.0018000	.0424270	.2	.1	78/04/12	82/11/10
					TOT	6	.0860000	.0026944	.0519080	.2	.04	78/04/12	83/05/11
74041	WQF	SAMPLE	UPDATED	BOTTOM		1	920110.0			920108	920108	91/08/13	91/08/13
				WATER		175	887300.0	1670E+05	12923.00	920109	860715	85/10/15	91/08/13
81886	PERTHANE	SED DRY	WGTUG/KG	WATER	K	1	20.00000			20.000	20.000	82/11/10	82/11/10
82007	% SAND	IN SED	DRY WGT	WATER		2	49.60000	3595.500	59.96300	92.00	7.20	82/06/03	82/11/10
82008	SEDIMENT	PARTSIZE	SILT	WATER		3	60.06700	2112.100	45.95700	86.60	7.00	82/06/03	82/11/10
82009	SEDIMENT	PARTSIZE	CLAY	WATER		3	4.466700	9.013300	3.002200	6.20	1.00	82/06/03	82/11/10
82302	RADON222	TOT.CT.	ER PC/L	WATER		1	1.000000			1.00	1.00	81/05/20	81/05/20

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0999 FEET DEPTH

/TYPA/AMBNT/ESTURY

PARAMETER			MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
82303 RADON222	TOTAL	PC/L	WATER	K	1	1.000000			1.00	1.00	81/05/20	81/05/20

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21CAOCFC 851123 HQ 18070201
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/TYPA/OUTFL/AMBNT/STREAM

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER		26	21.80400	26.58900	5.156500	32.1	13.6	85/10/15	92/03/23
00011	WATER	TEMP	FAHN	WATER	$	26	71.24700	86.14800	9.281600	89.8	56.5	85/10/15	92/03/23
00061	STREAM	FLOW,	INST-CFS	WATER		3	.7666700	.0633340	.2516600	1	.5	87/01/13	87/05/20
					J	9	2.777800	7.882000	2.807500	10	1	85/10/15	88/03/22
					TOT	12	2.275000	6.571200	2.563400	10	.5	85/10/15	88/03/22
00076	TURB	TRBIDMTR	HACH FTU	WATER		37	6.406200	259.9200	16.12200	90.0	.3	79/03/21	92/03/26
00094	CNDUCTVY	FIELD	MICROMHO	WATER		23	1270.000	221700.0	470.8500	2500	280	85/10/15	92/03/23
00095	CNDUCTVY	AT 25C	MICROMHO	WATER		37	3651.800	1111E+05	10543.00	50000	55	79/03/21	92/03/26
00116	INTNSVE	SURVEY	IDENT	WATER		9	730600.0	.0000000	.0000000	730601	730601	92/03/20	92/03/26
00300	DO		MG/L	WATER		11	13.46600	12.43200	3.525900	18.3	9.0	86/01/22	92/03/23
					L	13	15.38500	1.923100	1.386800	20.0	15.0	85/10/15	89/12/07
					TOT	24	14.50500	7.363000	2.713500	20.0	9.0	85/10/15	92/03/23
00301	DO	SATUR	PERCENT	WATER	$	24	163.6700	1414.800	37.61400	246.9	92.8	85/10/15	92/03/23
00400	PH		SU	WATER		24	8.785400	.5746100	.7580300	9.90	6.47	85/10/15	92/03/23
00403	PH	LAB	SU	WATER		37	8.181100	.5991400	.7740400	10.7	6.6	79/03/21	92/03/26
00530	RESIDUE	TOT NFLT	MG/L	WATER		18	22.88900	582.8100	24.14200	88	1	79/08/14	92/03/26
					K	21	5.000000	.0000000	.0000000	5	5	79/03/21	92/03/23
					TOT	39	13.25700	342.3500	18.50300	88	1	79/03/21	92/03/26
00535	RESIDUE	VOL NFLT	MG/L	WATER		17	11.17700	61.40500	7.836100	35	1	79/08/14	92/03/26
					K	21	4.904800	.1904900	.4364500	5	3	79/03/21	92/03/23
					TOT	38	7.710500	36.64400	6.053400	35	1	79/03/21	92/03/26
00550	OIL-GRSE	TOT-SXLT	MG/L	WATER		1	31.00000			31.0	31.0	86/10/14	86/10/14
					K	1	5.000000			5.0	5.0	85/10/15	85/10/15
					TOT	2	18.00000	338.0000	18.38500	31.0	5.0	85/10/15	86/10/14
00610	NH3+NH4-	N TOTAL	MG/L	WATER		18	.3883300	.1372700	.3705100	1.500	.060	79/04/17	92/03/26
					K	21	.1000000	.0000000	.0000000	.100	.100	79/03/21	92/03/23
					TOT	39	.2330800	.0826170	.2874300	1.500	.060	79/03/21	92/03/26
00612	UN-IONZD	NH3-N	MG/L	WATER	$	6	.1177100	.0361470	.1901200	.499	.015	86/03/19	89/12/07
00619	UN-IONZD	NH3-NH3	MG/L	WATER	$	6	.1431200	.0534390	.2311700	.606	.018	86/03/19	89/12/07
00625	TOT KJEL	N	MG/L	WATER		39	1.666700	1.597600	1.264000	6.900	.300	79/03/21	92/03/26
00650	T PO4	PO4	MG/L	WATER		33	1.169700	1.177800	1.085300	5.30	.10	79/03/21	92/03/26
					K	6	.4333300	.0266670	.1633000	.50	.10	79/04/17	89/12/07
					TOT	39	1.056400	1.067800	1.033300	5.30	.10	79/03/21	92/03/26
00680	T ORG C	C	MG/L	WATER		3	12.33300	44.08400	6.639600	20.0	8.5	85/10/14	86/10/13
00900	TOT HARD	CACO3	MG/L	WATER		8	153.7500	8897.400	94.32600	268	32	92/03/20	92/03/26
01002	ARSENIC	AS,TOT	UG/L	WATER	K	3	16.00000	28.00000	5.291500	20	10	85/10/14	87/05/20
01027	CADMIUM	CD,TOT	UG/L	WATER		1	2.200000			2	2	85/10/14	85/10/14
					K	8	16.75000	36.21400	6.017800	20	7	92/03/20	92/03/26
					TOT	9	15.13300	55.21000	7.430400	20	2	85/10/14	92/03/26

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21CAOCFC 851123 HQ 18070201
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/TYPA/OUTFL/AMBNT/STREAM

PARAMETER			MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
01034 CHROMIUM	CR,TOT	UG/L	WATER		6	4.966700	4.326700	2.080100	7	2	86/04/14	88/01/19
				K	18	14.38900	144.1400	12.00600	30	3	85/10/14	92/03/26
				TOT	24	12.03300	124.8500	11.17300	30	2	85/10/14	92/03/26
01042 COPPER	CU,TOT	UG/L	WATER		16	19.37500	125.1800	11.18900	47	8	85/10/14	92/03/26
				K	8	21.25000	155.3600	12.46400	50	10	86/01/21	92/03/23
				TOT	24	20.00000	129.7400	11.39000	50	8	85/10/14	92/03/26
01045 IRON	FE,TOT	UG/L	WATER		1	550.0000			550	550	85/10/14	85/10/14
01051 LEAD	PB,TOT	UG/L	WATER		14	10.67900	54.52300	7.384000	29	2	85/10/14	92/03/26
				K	10	9.400000	141.6000	11.90000	40	2	86/01/21	92/03/23
				TOT	24	10.14600	86.64100	9.308100	40	2	85/10/14	92/03/26
01067 NICKEL	NI,TOTAL	UG/L	WATER	K	8	32.50000	192.8600	13.88700	40	10	92/03/20	92/03/26
01077 SILVER	AG,TOT	UG/L	WATER		1	39.00000			39.0	39.0	92/03/26	92/03/26
				K	7	8.857200	9.142900	3.023700	10.0	2.0	92/03/20	92/03/26
				TOT	8	12.62500	121.4100	11.01900	39.0	2.0	92/03/20	92/03/26
01092 ZINC	ZN,TOT	UG/L	WATER		22	76.63600	2917.800	54.01600	200	20	85/10/14	92/03/26
				K	2	15.00000	50.00000	7.071100	20	10	87/02/10	87/03/10
				TOT	24	71.50000	2969.100	54.48900	200	10	85/10/14	92/03/26
01147 SELENIUM	SE,TOT	UG/L	WATER	K	3	25.33300	165.3300	12.85800	40	16	85/10/14	87/05/20
34259 DELTABHC		TOTUG/L	WATER	K	1	.0500000			.050	.050	85/10/15	85/10/15
34351 ENDSULSF		TOTUG/L	WATER	K	1	.1000000			.100	.100	85/10/15	85/10/15
34356 B-ENDO	SULFAN	TOTWUG/L	WATER	K	1	.0500000			.050	.050	85/10/15	85/10/15
34361 A-ENDO	SULFAN	TOTWUG/L	WATER	K	1	.0500000			.050	.050	85/10/15	85/10/15
34671 PCB	1016	TOTWUG/L	WATER	K	1	1.000000			1.000	1.000	85/10/15	85/10/15
38260 MBAS		MG/L	WATER	K	2	.1000000	.0000000	.0000000	.10	.10	85/10/15	86/10/14
39034 PERTHANE	WHL SMPL	UG/L	WATER	K	1	.5000000			.500	.500	85/10/15	85/10/15
39055 SIMAZINE	WH.WATER	(UG/L)	WATER	K	1	.5000000			.5	.5	85/10/15	85/10/15
39330 ALDRIN		TOT UG/L	WATER	K	1	.0500000			.050	.050	85/10/15	85/10/15
39337 ALPHABHC		TOTUG/L	WATER	K	1	.0500000			.050	.050	85/10/15	85/10/15
39338 BETA BHC		TOTUG/L	WATER	K	1	.0500000			.050	.050	85/10/15	85/10/15
39350 CHLRDANE	TECH&MET	TOT UG/L	WATER	K	1	.3000000			.300	.300	85/10/15	85/10/15
39360 DDD	WHL SMPL	UG/L	WATER	K	1	.0500000			.050	.050	85/10/15	85/10/15
39365 DDE	WHL SMPL	UG/L	WATER	K	1	.0500000			.050	.050	85/10/15	85/10/15
39370 DDT	WHL SMPL	UG/L	WATER	K	1	.1000000			.100	.100	85/10/15	85/10/15
39380 DIELDRIN		TOTUG/L	WATER	K	1	.0500000			.050	.050	85/10/15	85/10/15
39390 ENDRIN		TOT UG/L	WATER	K	1	.1000000			.100	.100	85/10/15	85/10/15
39400 TOXAPHEN		TOTUG/L	WATER	K	1	1.000000			1.000	1.000	85/10/15	85/10/15
39410 HEPTCHLR		TOTUG/L	WATER	K	1	.0500000			.050	.050	85/10/15	85/10/15
39420 HPCHLREP		TOTUG/L	WATER	K	1	.0500000			.050	.050	85/10/15	85/10/15
39480 MTHXYCLR	WHL SMPL	UG/L	WATER	K	1	.3000000			.300	.300	85/10/15	85/10/15

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21CAOCFC 851123 HQ 18070201
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PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
39488	PCB-1221		TOTUG/L	WATER	K	1	1.000000			1.000	1.000	85/10/15	85/10/15
39492	PCB-1232		TOTUG/L	WATER	K	1	1.000000			1.000	1.000	85/10/15	85/10/15
39496	PCB-1242		TOTUG/L	WATER	K	1	1.000000			1.000	1.000	85/10/15	85/10/15
39500	PCB-1248		TOTUG/L	WATER	K	1	1.000000			1.000	1.000	85/10/15	85/10/15
39504	PCB-1254		TOTUG/L	WATER	K	1	1.000000			1.000	1.000	85/10/15	85/10/15
39508	PCB-1260		TOTUG/L	WATER	K	1	1.000000			1.000	1.000	85/10/15	85/10/15
39530	MALATHN	WHL SMPL	UG/L	WATER	K	1	1.000000			1.000	1.000	85/10/15	85/10/15
39540	PARATHN	WHL SMPL	UG/L	WATER	K	1	1.000000			1.000	1.000	85/10/15	85/10/15
39730	2,4-D	WHL SMPL	UG/L	WATER	K	1	5.000000			5.000	5.000	85/10/15	85/10/15
39760	SILVEX	WHL SMPL	UG/L	WATER	K	1	1.000000			1.000	1.000	85/10/15	85/10/15
39782	LINDANE	WHL SMPL	UG/L	WATER	K	1	.0500000			.050	.050	85/10/15	85/10/15
71850	NITRATE	TOT-NO3	MG/L	WATER		26	7.856500	115.4200	10.74300	56.0	.4	86/01/21	92/03/26
					K	10	1.163000	2.944400	1.715900	4.4	.2	79/03/21	90/06/19
					TOT	36	5.997200	92.44400	9.614800	56.0	.2	79/03/21	92/03/26
74041	WQF	SAMPLE	UPDATED	WATER		62	888430.0	3283E+05	18122.00	920708	860715	79/03/21	92/03/26

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LOS ALIMITOS RETARDING
21CAOCFC HQ 18070106002 0001.340 OFF
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PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER		12	19.90000	21.61100	4.648800	26.0	12.0	73/05/30	81/05/19
00011	WATER	TEMP	FAHN	WATER	$	12	67.82000	70.03100	8.368500	78.8	53.6	73/05/30	81/05/19
00061	STREAM	FLOW,	INST-CFS	WATER	J	6	.6250000	.4937500	.7026700	2	0	74/07/09	80/05/22
00076	TURB	TRBIDMTR	HACH FTU	WATER		10	15.31000	816.8000	28.58000	90.0	.6	73/05/30	81/05/19
00094	CNDUCTVY	FIELD	MICROMHO	WATER		4	6018.800	35626000	5968.700	14000	525	77/01/25	81/05/19
00095	CNDUCTVY	AT 25C	MICROMHO	WATER		12	6004.300	98646000	9932.100	36600	232	73/05/30	81/05/19
00300	DO		MG/L	WATER		8	8.650000	5.308700	2.304100	11.3	4.6	75/01/07	81/05/19
					L	1	15.00000			15.0	15.0	78/11/07	78/11/07
					TOT	9	9.355600	9.125400	3.020800	15.0	4.6	75/01/07	81/05/19
00301	DO	SATUR	PERCENT	WATER	$	9	101.7000	1140.700	33.77400	166.7	50.0	75/01/07	81/05/19
00335	COD	LOWLEVEL	MG/L	WATER		3	119.3300	9202.400	95.92900	229.0	51.0	76/04/07	78/11/07
00400	PH		SU	WATER		5	8.260000	.2180800	.4669900	9.00	7.70	77/01/25	81/05/19
00403	PH	LAB	SU	WATER		12	7.850000	.2300300	.4796100	8.9	7.2	73/05/30	81/05/19
00440	HCO3 ION	HCO3	MG/L	WATER		1	162.0000			162	162	73/05/30	73/05/30
00445	CO3 ION	CO3	MG/L	WATER		1	.0000000			0	0	73/05/30	73/05/30
00530	RESIDUE	TOT NFLT	MG/L	WATER		11	146.2900	41427.00	203.5400	634	11	74/01/07	81/05/19
00535	RESIDUE	VOL NFLT	MG/L	WATER		4	11.25000	156.2800	12.50100	29	1	78/11/07	81/05/19
00550	OIL-GRSE	TOT-SXLT	MG/L	WATER		2	5.100000	.0200200	.1414900	5.2	5.0	75/07/01	80/10/14
00610	NH3+NH4-	N TOTAL	MG/L	WATER		5	.3200000	.0170000	.1303900	.500	.200	75/07/01	81/05/19
					K	7	.1328600	.0055571	.0745460	.300	.100	73/05/30	80/05/22
					TOT	12	.2108300	.0184990	.1360100	.500	.100	73/05/30	81/05/19
00612	UN-IONZD	NH3-N	MG/L	WATER	$	12	.0131360	.0001850	.0136030	.035	.0008	73/05/30	81/05/19
00619	UN-IONZD	NH3-NH3	MG/L	WATER	$	12	.0159720	.0002735	.0165400	.043	.001	73/05/30	81/05/19
00625	TOT KJEL	N	MG/L	WATER		12	2.390800	1.985900	1.409200	5.700	.300	73/05/30	81/05/19
00650	T PO4	PO4	MG/L	WATER		12	1.131700	.5162900	.7185300	2.57	.30	73/05/30	81/05/19
00915	CALCIUM	CA,DISS	MG/L	WATER		1	73.00000			73.0	73.0	73/05/30	73/05/30
00925	MGNSIUM	MG,DISS	MG/L	WATER		1	34.00000			34.0	34.0	73/05/30	73/05/30
00930	SODIUM	NA,DISS	MG/L	WATER		1	400.0000			400.00	400.00	73/05/30	73/05/30
00935	PTSSIUM	K,DISS	MG/L	WATER		1	17.20000			17.20	17.20	73/05/30	73/05/30
00940	CHLORIDE	TOTAL	MG/L	WATER		1	575.0000			575	575	73/05/30	73/05/30
00945	SULFATE	SO4-TOT	MG/L	WATER		1	247.0000			247	247	73/05/30	73/05/30
00950	FLUORIDE	F,DISS	MG/L	WATER		1	1.000000			1.00	1.00	73/05/30	73/05/30
00955	SILICA	DISOLVED	MG/L	WATER		11	6.609100	14.85900	3.854700	14.0	2.0	73/05/30	80/10/14
01002	ARSENIC	AS,TOT	UG/L	WATER		4	11.75000	27.58300	5.252000	15	4	77/01/25	81/05/19
01020	BORON	B,DISS	UG/L	WATER		1	550.0000			550	550	73/05/30	73/05/30
01027	CADMIUM	CD,TOT	UG/L	WATER		5	5.600000	5.300000	2.302200	8	2	76/04/07	81/05/19
01034	CHROMIUM	CR,TOT	UG/L	WATER		3	25.66700	780.3400	27.93500	56	1	76/04/07	78/11/07
					K	3	6.666700	8.333400	2.886800	10	5	80/05/22	81/05/19
					TOT	6	16.16700	423.7700	20.58600	56	1	76/04/07	81/05/19

LABC01
33 43 22.0 118 05 45.0 2
AT PUMP STATION INLET
06059 CALIFORNIA ORANGE
SAN GABRIEL RIVER BASIN 140700
/TYPA/AMBNT/STREAM
LOS ALIMITOS RETARDING
21CAOCFC HQ 18070106002 0001.340 OFF
0999 FEET DEPTH

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
01042	COPPER	CU,TOT	UG/L	WATER		6	25.33300	144.6700	12.02800	44	16	76/04/07	81/05/19
01051	LEAD	PB,TOT	UG/L	WATER		6	128.3300	12534.00	111.9500	330	36	74/01/07	80/10/14
					K	2	11.50000	4.500000	2.121300	13	10	80/05/22	81/05/19
					TOT	8	99.12500	11878.00	108.9900	330	10	74/01/07	81/05/19
01092	ZINC	ZN,TOT	UG/L	WATER		6	105.6700	5333.500	73.03100	220	16	76/04/07	81/05/19
01147	SELENIUM	SE,TOT	UG/L	WATER		2	21.00000	288.0000	16.97100	33	9	77/01/25	81/05/19
					K	2	2.000000	.0000000	.0000000	2	2	78/11/07	80/10/14
					TOT	4	11.50000	216.3300	14.70800	33	2	77/01/25	81/05/19
31507	TOT COLI	MPN COMP	/100ML	WATER		4	7700.000	40120000	6334.000	15000	2400	75/01/07	80/10/14
32730	PHENOLS	TOTAL	UG/L	WATER	K	1	50.00000			50	50	80/10/14	80/10/14
38260	MBAS		MG/L	WATER		1	.1400000			.14	.14	80/10/14	80/10/14
46570	CAL HARD	CA MG	MG/L	WATER	$	1	322.2900			322	322	73/05/30	73/05/30
70301	DISS SOL	SUM	MG/L	WATER		1	1431.000			1431	1431	73/05/30	73/05/30
71850	NITRATE	TOT-NO3	MG/L	WATER		9	5.244400	26.24500	5.123000	13.4	.1	73/05/30	81/05/19
					K	3	.3000000	.0300000	.1732100	.4	.1	74/07/09	80/10/14
					TOT	12	4.008300	24.09400	4.908500	13.4	.1	73/05/30	81/05/19
71885	IRON	FE	UG/L	WATER		1	4800.000			4800.00	4800.00	77/01/25	77/01/25
71900	MERCURY	HG,TOTAL	UG/L	WATER		2	.7000000	.0000000	.0000000	.7	.7	77/01/25	78/11/07
					K	2	2.000000	2.000000	1.414200	3.0	1.0	80/10/14	81/05/19
					TOT	4	1.350000	1.230000	1.109100	3.0	.7	77/01/25	81/05/19

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ALAMITOS BARRIER PROJECT
06037 CALIFORNIA LOS ANGELES
140692

/TYPA/AMBNT/WELL

21CALAFD 18070106
0999 FEET DEPTH

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER	$	5	22.00000	.4014300	.6335800	22.8	21.1	76/02/05	76/03/12
00011	WATER	TEMP	FAHN	WATER		5	71.60000	1.305700	1.142700	73.0	70.0	76/02/05	76/03/12
00056	FLOW	RATE	GPD	WATER		5	132940.0	4792E+06	69225.00	213299	71100	76/02/05	76/03/12
00310	BOD	5 DAY	MG/L	WATER		5	45.20000	724.7000	26.92000	90.0	17.0	76/02/05	76/03/12
00400	PH		SU	WATER		5	7.630000	.0420530	.2050700	7.80	7.30	76/02/05	76/03/12
00545	RESIDUE	SETTLBLE	ML/L	WATER		6	.1466700	.0304670	.1745500	.5	.05	76/02/05	76/03/12
00745	SULFIDE	TOTAL	MG/L	WATER		3	11.66700	33.33400	5.773500	15.00	5.00	76/02/05	76/03/10
					L	1	15.00000			15.00	15.00	76/03/12	76/03/12
					TOT	4	12.50000	25.00000	5.000000	15.00	5.00	76/02/05	76/03/12
72005	SAMPLE	SOURCE	CODE	WATER		5	1.000000	.0000000	.0000000	1	1	76/02/05	76/03/12
85001	BOD	5 DAY	#/DAY	WATER		5	34.57400	882.8900	29.71400	73	2	76/02/05	76/03/12

BCC02
33 45 35.0 118 02 30.0 3
AT BOLSA AVENUE EXTENSION BRIDGE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
/TYPA/AMBNT/STREAM
BOLSA CHICA CHANNEL D/S C02/C03
21CAOCFC 18070201
0000 FEET DEPTH

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER		190	17.84800	20.76500	4.556800	30.0	8.0	73/04/06	92/02/07
					J	1	24.00000			24.0	24.0	73/06/04	73/06/04
					TOT	191	17.88100	20.85400	4.566600	30.0	8.0	73/04/06	92/02/07
00011	WATER	TEMP	FAHN	WATER	$	191	64.18400	67.73200	8.230000	86.0	46.4	73/04/06	92/02/07
00060	STREAM	FLOW	CFS	WATER		42	86.03300	26532.00	162.8900	792	.3	76/02/03	78/05/09
00061	STREAM	FLOW,	INST-CFS	WATER		91	104.2500	89320.00	298.8600	2330	.3	76/02/03	92/02/07
					J	76	16.96600	3000.400	54.77600	400	0	73/04/06	88/07/21
					TOT	167	64.52900	51683.00	227.3400	2330	0	73/04/06	92/02/07
00076	TURB	TRBIDMTR	HACH FTU	WATER		179	21.49400	2146.600	46.33200	390.0	.2	73/05/08	92/02/05
00093	SOLIDS	FLOAT	MG/L	WATER		4	1142.500	235890.0	485.6900	1450.0	420.0	81/09/14	82/09/20
00094	CNDUCTVY	FIELD	MICROMHO	WATER		125	1508.400	3470400	1862.900	16400	40	77/01/25	92/02/07
00095	CNDUCTVY	AT 25C	MICROMHO	WATER		198	1480.500	7254100	2693.300	37000	63	66/07/07	92/02/05
00116	INTNSVE	SURVEY	IDENT	WATER		59	730600.0	.0000000	.0000000	730601	730601	73/11/17	92/02/07
00300	DO		MG/L	WATER		156	8.612700	11.21200	3.348400	15.0	.8	74/10/08	91/12/11
					L	9	15.55600	2.777800	1.666700	20.0	15.0	78/01/06	89/05/22
					TOT	165	8.991400	13.23300	3.637700	20.0	.8	74/10/08	91/12/11
00301	DO	SATUR	PERCENT	WATER	$	164	93.15500	1529.700	39.11100	238.1	8.5	74/10/08	91/12/11
00310	BOD	5 DAY	MG/L	WATER		8	6.637500	36.49700	6.041300	21.0	3.0	73/11/17	81/05/19
00335	COD	LOWLEVEL	MG/L	WATER		42	55.45200	1055.800	32.49300	133.0	12.0	75/07/01	79/10/08
					K	1	2.000000			2.0	2.0	78/02/09	78/02/09
					TOT	43	54.20900	1097.100	33.12300	133.0	2.0	75/07/01	79/10/08
00400	PH		SU	WATER		131	7.768900	.3798100	.6162900	9.40	5.80	76/06/02	92/02/07
00403	PH	LAB	SU	WATER		197	7.813900	.3472000	.5892400	10.2	6.2	66/07/07	92/02/05
					K	1	2.000000			2.0	2.0	86/11/18	86/11/18
					TOT	198	7.784600	.5161400	.7184300	10.2	2.0	66/07/07	92/02/05
00405	CO2		MG/L	WATER		3	8.533300	31.45400	5.608300	15.0	5.0	77/07/12	84/05/14
00440	HCO3 ION	HCO3	MG/L	WATER		8	162.6000	24398.00	156.2000	380	0	66/07/07	86/10/13
00445	CO3 ION	CO3	MG/L	WATER		3	43.66700	792.3400	28.14900	70	14	66/07/07	73/06/04
00515	RESIDUE	DISS-105 C	MG/L	WATER		1	9.000000			9	9	73/10/02	73/10/02
00530	RESIDUE	TOT NFLT	MG/L	WATER		172	105.1900	44665.00	211.3400	1995	.8	73/07/09	92/02/05
					K	24	3.895800	3.825700	1.955900	5	.5	79/03/21	91/11/06
					TOT	196	92.78700	40277.00	200.6900	1995	.5	73/07/09	92/02/05
00535	RESIDUE	VOL NFLT	MG/L	WATER		110	22.08500	532.5400	23.07700	130	.4	74/12/04	92/02/05
					K	30	3.633300	4.050600	2.012600	5	.5	75/02/03	91/08/05
					TOT	140	18.13100	476.1800	21.82200	130	.4	74/12/04	92/02/05
00550	OIL-GRSE	TOT-SXLT	MG/L	WATER		34	13.54700	1497.900	38.70200	230.0	.2	74/01/07	88/03/07
					K	4	2.550000	8.003300	2.829000	5.0	.1	81/05/19	87/12/16
					TOT	38	12.39000	1348.300	36.71900	230.0	.1	74/01/07	88/03/07
00610	NH3+NH4-	N TOTAL	MG/L	WATER		121	.5176000	.2570500	.5070000	3.100	.040	73/06/04	92/02/05

BCC02
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AT BOLSA AVENUE EXTENSION BRIDGE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
/TYPA/AMBNT/STREAM
BOLSA CHICA CHANNEL D/S C02/C03
21CAOCFC 18070201
0000 FEET DEPTH

PARAMETER		MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00610 NH3+NH4- N TOTAL	MG/L	WATER	K	79	.1297500	.0085306	.0923610	.500	.050	73/04/06	91/11/06
00610 NH3+NH4- N TOTAL	MG/L	WATER	TOT	200	.3644000	.1944800	.4409900	3.100	.040	73/04/06	92/02/05
00612 UN-IONZD NH3-N	MG/L	WATER	$	126	.0147060	.0012037	.0346940	.284	.0001	73/04/06	89/12/07
00619 UN-IONZD NH3-NH3	MG/L	WATER	$	126	.0178810	.0017795	.0421840	.346	.0002	73/04/06	89/12/07
00625 TOT KJEL N	MG/L	WATER		194	2.638900	29.15800	5.399900	74.800	.300	73/05/08	92/02/05
			K	5	.2800000	.0420000	.2049400	.500	.100	74/07/09	92/01/05
			TOT	199	2.579600	28.56000	5.344100	74.800	.100	73/05/08	92/02/05
00650 T PO4 PO4	MG/L	WATER		180	1.521900	32.48500	5.699600	52.00	.06	73/04/06	92/02/05
			K	19	.3010500	.0498880	.2233600	.50	.01	73/10/02	89/01/18
			TOT	199	1.405300	29.50200	5.431600	52.00	.01	73/04/06	92/02/05
00668 PHOS MUD DRY WGT	MG/KG-P	WATER		7	409.3000	269850.0	519.4700	1300.0	8.0	80/10/14	86/10/14
00680 T ORG C C	MG/L	WATER		3	14.43300	7.163500	2.676500	17.3	12.0	83/11/08	86/10/13
00721 CYANIDE SEDMG/KG	DRY WGT	WATER	K	1	.0300000			.03	.03	80/10/14	80/10/14
00747 SULFIDE IN SED.	MG/KG	WATER		1	2.600000			2.60	2.60	82/11/09	82/11/09
			K	5	.9200000	.2570000	.5069500	1.50	.10	80/10/14	85/10/15
			TOT	6	1.200000	.6760000	.8221900	2.60	.10	80/10/14	85/10/15
00900 TOT HARD CACO3	MG/L	WATER		9	276.4500	19996.00	141.4100	430	41	73/06/04	92/02/05
00915 CALCIUM CA,DISS	MG/L	WATER		7	77.14300	939.8100	30.65600	120.0	19.0	66/07/07	86/10/13
00925 MGNSIUM MG,DISS	MG/L	WATER		7	35.62900	69.81600	8.355600	46.0	20.0	66/07/07	86/10/13
00930 SODIUM NA,DISS	MG/L	WATER		6	375.5000	62518.00	250.0400	870.00	208.00	73/05/08	86/10/13
00935 PTSSIUM K,DISS	MG/L	WATER		6	9.850000	20.79900	4.560600	18.00	4.50	73/05/08	86/10/13
00940 CHLORIDE TOTAL	MG/L	WATER		7	340.7200	170790.0	413.2700	1268	106	66/07/07	86/10/13
00945 SULFATE SO4-TOT	MG/L	WATER		6	374.3300	4812.400	69.37100	490	312	73/05/08	86/10/13
00950 FLUORIDE F,DISS	MG/L	WATER		6	1.040000	.1160000	.3405900	1.60	.64	73/05/08	86/10/13
00955 SILICA DISOLVED	MG/L	WATER		118	7.895700	22.47300	4.740600	21.0	.4	73/04/06	86/10/13
			K	3	.8333300	.0833340	.2886800	1.0	.5	76/09/10	80/03/03
			TOT	121	7.720600	23.12900	4.809200	21.0	.4	73/04/06	86/10/13
01002 ARSENIC AS,TOT	UG/L	WATER		9	6.555600	35.02800	5.918400	16	2	76/04/06	84/05/14
			K	12	5.625000	39.23300	6.263600	18	.5	73/04/06	87/05/20
			TOT	21	6.023800	35.81200	5.984300	18	.5	73/04/06	87/05/20
01003 ARSENIC SEDMG/KG	DRY WGT	WATER		13	5.401500	52.43800	7.241400	26.00	.25	78/11/07	86/10/14
01020 BORON B,DISS	UG/L	WATER		6	417.5000	10258.00	101.2800	570	310	73/05/08	86/10/13
01027 CADMIUM CD,TOT	UG/L	WATER		45	7.515600	252.2400	15.88200	100	1	73/07/16	85/10/14
			K	14	7.500000	70.11500	8.373500	20	1	73/04/06	92/02/05
			TOT	59	7.511900	207.0700	14.39000	100	1	73/04/06	92/02/05
01028 CD MUD DRY WGT	MG/KG-CD	WATER		9	.4911100	.0467860	.2163000	.71	.15	78/11/07	85/10/15
			K	5	.4440000	.0276300	.1662200	.60	.17	80/05/13	86/10/14
			TOT	14	.4742900	.0378420	.1945300	.71	.15	78/11/07	86/10/14
01029 CHROMIUM SEDMG/KG	DRY WGT	WATER		14	12.68600	57.68900	7.595300	27.00	1.80	78/11/07	86/10/14

BCC02
33 45 35.0 118 02 30.0 3
AT BOLSA AVENUE EXTENSION BRIDGE
06059 CALIFORNIA ORANGE
SANTA ANA RIVER BASIN 140700
/TYPA/AMBNT/STREAM BOLSA CHICA CHANNEL D/S C02/C03
21CAOCFC 18070201
0000 FEET DEPTH

PARAMETER	MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
01034 CHROMIUM CR,TOT UG/L	WATER		55	13.88200	125.4000	11.19800	50	2	74/01/07	88/03/22
		K	40	11.67500	314.2300	17.72600	100	1	74/07/09	92/02/05
		TOT	95	12.95300	203.6100	14.26900	100	1	74/01/07	92/02/05
01042 COPPER CU,TOT UG/L	WATER		119	31.74900	717.3700	26.78400	200	3	73/07/16	92/02/05
		K	10	13.20000	187.9600	13.71000	50	4	78/04/07	90/06/19
		TOT	129	30.31100	699.3400	26.44500	200	3	73/07/16	92/02/05
01043 COPPER SEDMG/KG DRY WGT	WATER		14	22.42900	161.4400	12.70600	59.00	2.20	78/11/07	86/10/14
01045 IRON FE,TOT UG/L	WATER		2	580.0000	7200.000	84.85300	640	520	80/01/22	83/11/07
		K	1	200.0000			200	200	85/10/14	85/10/14
		TOT	3	453.3300	51734.00	227.4500	640	200	80/01/22	85/10/14
01051 LEAD PB,TOT UG/L	WATER		129	90.14700	13717.00	117.1200	630	4	73/04/06	92/02/05
		K	34	16.32400	255.5600	15.98600	70	1	75/01/06	90/06/19
		TOT	163	74.74900	11796.00	108.6100	630	1	73/04/06	92/02/05
01052 LEAD SEDMG/KG DRY WGT	WATER		13	36.38400	1116.000	33.40600	90.00	.69	78/11/07	85/10/15
01067 NICKEL NI,TOTAL UG/L	WATER		1	40.00000			40	40	91/10/26	91/10/26
		K	4	40.00000	.0000000	.0000000	40	40	92/01/05	92/02/05
		TOT	5	40.00000	.0000000	.0000000	40	40	91/10/26	92/02/05
01077 SILVER AG,TOT UG/L	WATER	K	5	8.400000	12.80000	3.577700	10.0	2.0	91/10/26	92/02/05
01092 ZINC ZN,TOT UG/L	WATER		134	85.09700	7502.700	86.61800	420	6	73/04/06	92/02/05
		K	11	18.27300	97.21900	9.860000	30	2	73/07/16	90/06/19
		TOT	145	80.02800	7251.600	85.15600	420	2	73/04/06	92/02/05
01093 ZINC SEDMG/KG DRY WGT	WATER		14	90.69300	8446.400	91.90400	378.00	7.70	78/11/07	86/10/14
01143 SILICON SILICATE UG/L SI	WATER	K	1	.1000000			.1	.1	83/05/10	83/05/10
01147 SELENIUM SE,TOT UG/L	WATER		11	6.163600	33.83100	5.816400	20	1	73/04/06	82/06/01
		K	10	7.900000	42.32200	6.505600	20	2	77/07/12	87/05/20
		TOT	21	6.990500	36.75000	6.062200	20	1	73/04/06	87/05/20
01148 SELENIUM SEDMG/KG DRY WGT	WATER		2	.1345000	.0222610	.1492000	.24	.03	80/05/13	81/05/19
		K	11	.5163600	.2068900	.4548500	1.50	.06	78/11/07	86/10/14
		TOT	13	.4576200	.1948200	.4413900	1.50	.03	78/11/07	86/10/14
01170 FE MUD DRY WGT MG/KG-FE	WATER		3	14100.00	34930000	5910.200	18000.00	7300.00	83/11/08	86/10/14
01501 ALPHA TOTAL PC/L	WATER		8	13.42600	152.4400	12.34700	34	.7	83/05/10	89/03/08
		K	1	17.00000			17	17	82/11/09	82/11/09
		TOT	9	13.82300	134.8000	11.61100	34	.7	82/11/09	89/03/08
01502 ALPHA-T ERROR PC/L	WATER		5	7.040000	36.45300	6.037600	14	.9	84/05/15	87/12/16
03501 BETA TOTAL PC/L	WATER		7	18.20200	635.5900	25.21100	55	-6	84/05/15	89/03/08
		K	2	13.65000	80.64500	8.980300	20	7	82/11/09	83/05/10
		TOT	9	17.19000	490.8000	22.15400	55	-6	82/11/09	89/03/08
03502 BETA-T ERROR PC/L	WATER		5	13.90000	53.47000	7.312300	21	3	84/05/15	87/12/16
09501 RA-226 TOTAL PC/L	WATER		3	.2800000	.0768000	.2771300	.6	.1	85/10/15	87/05/20

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09502 RA-226 ERROR PC/L	WATER		3	.0733330	.0006333	.0251660	.1	.05	85/10/15	87/05/20
31507 TOT COLI MPN COMP /100ML	WATER		104	187180.0	2255E+08	474950.0	2400000	200	74/12/04	82/09/21
		L	2	2400000	.0000000	.0000000	2400000	2400000	80/03/03	81/10/02
		TOT	106	228930.0	3127E+08	559280.0	2400000	200	74/12/04	82/09/21
31615 FEC COLI MPNECMED /100ML	WATER		3	370640.0	3989E+08	631660.0	1100000	930	75/10/07	77/10/11
31677 FECSTREP MPNADEVA /100ML	WATER		1	430.0000			430	430	75/10/07	75/10/07
32730 PHENOLS TOTAL UG/L	WATER	K	12	35.83300	317.4300	17.81700	50	10	77/01/25	82/11/09
32860 INVALID PAR NUMBER	WATER	K	1	.0100000			.0100000	.0100000	78/04/11	78/04/11
34257 BETA BHC SEDUG/KG DRY WGT	WATER	K	10	17.70000	888.2300	29.80300	100.000	.002	82/11/09	89/01/18
34259 DELTABHC TOTUG/L	WATER	K	10	1.029200	9.936200	3.152200	10.000	.002	82/11/09	89/01/18
34262 DELTABHC SEDUG/KG DRY WGT	WATER	K	9	19.66700	955.7500	30.91500	100.000	1.000	82/11/09	88/03/08
34337 DIETHYLP HTHALATE DISSUG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
34338 DIETHYLP HTHALATE SUSPUG/L	WATER	K	1	10.00000			10.000	10.000	82/11/09	82/11/09
34351 ENDSULSF TOTUG/L	WATER	K	12	1.042800	8.090200	2.844300	10.000	.003	82/11/09	89/01/18
34354 ENDSULSF SEDUG/KG DRY WGT	WATER	K	10	52.60000	7995.300	89.41700	300.000	.003	82/11/09	89/01/18
34356 B-ENDO SULFAN TOTWUG/L	WATER	K	11	1.023800	8.948100	2.991300	10.000	.002	82/11/09	89/01/18
34359 BENDOSUL SEDUG/KG DRY WGT	WATER	K	10	19.70000	894.0000	29.90000	100.000	.002	82/11/09	89/01/18
34361 A-ENDO SULFAN TOTWUG/L	WATER	K	11	1.020200	8.956000	2.992700	10.000	.002	82/11/09	89/01/18
34364 AENDOSUL SEDUG/KG DRY WGT	WATER	K	10	19.70000	894.0000	29.90000	100.000	.002	82/11/09	89/01/18
34491 TRCLFLMT SEDUG/KG DRY WGT	WATER	K	1	.0020000			.002	.002	89/01/18	89/01/18
34671 PCB 1016 TOTWUG/L	WATER	K	13	.6561500	.1544900	.3930600	1.000	.030	81/11/10	89/01/18
38260 MBAS MG/L	WATER		7	.2214300	.0411480	.2028500	.52	.05	74/10/08	82/11/09
		K	9	.0700000	.0020250	.0450000	.10	.01	74/12/04	86/10/14
		TOT	16	.1362500	.0235580	.1534900	.52	.01	74/10/08	86/10/14
39034 PERTHANE WHL SMPL UG/L	WATER	K	17	1.706400	5.437600	2.331900	10.000	.003	74/01/07	89/01/18
39046 SIMAZINE MUD UG/GK	WATER	K	10	706.5100	2389900	1546.000	5000.00	.10	79/05/09	89/01/18
39055 SIMAZINE WH.WATER (UG/L)	WATER	K	11	1.600000	2.910000	1.705900	5	.1	79/05/09	89/01/18
39076 ALPHABHC SEDUG/KG DRY WGT	WATER	K	9	17.83400	1004.800	31.69800	100.000	.002	82/11/09	89/01/18
39330 ALDRIN TOT UG/L	WATER		2	.5020000	.4960100	.7042800	1.000	.004	88/03/08	89/01/18
		K	22	.4764600	.2401700	.4900700	1.000	.002	74/01/07	88/04/20
		TOT	24	.4785800	.2409000	.4908200	1.000	.002	74/01/07	89/01/18
39333 ALDRIN SEDUG/KG DRY WGT	WATER		1	.0040000			.004	.004	89/01/18	89/01/18
		K	17	15.70600	533.3200	23.09400	100.00	.50	78/11/07	88/03/08
		TOT	18	14.83400	515.6400	22.70800	100.00	.004	78/11/07	89/01/18
39337 ALPHABHC TOTUG/L	WATER	K	10	.1182000	.0964430	.3105500	1.000	.002	83/05/09	89/01/18
39338 BETA BHC TOTUG/L	WATER	K	10	.1202000	.0959470	.3097500	1.000	.002	83/05/09	89/01/18
39340 GAMMABHC LINDANE TOT.UG/L	WATER		1	.0180000			.018	.018	74/01/07	74/01/07
		K	15	.6273300	.2237100	.4729800	1.000	.010	75/07/01	84/05/15
		TOT	16	.5892500	.2320000	.4816600	1.000	.010	74/01/07	84/05/15

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39343	GBHC-MUD LINDANE DRYUG/KG	WATER	K	12	12.62500	67.14200	8.194000	20.00	.50	78/11/07	84/05/15
39350	CHLRDANE TECH&MET TOT UG/L	WATER		1	.1000000			.100	.100	78/04/11	78/04/11
			K	23	.5446100	.1867500	.4321500	1.000	.006	74/01/07	89/01/18
			TOT	24	.5260800	.1868700	.4322800	1.000	.006	74/01/07	89/01/18
39351	CDANEDRY TECH&MET MUDUG/KG	WATER	K	18	57.52800	13374.00	115.6500	500.00	.01	78/11/07	89/01/18
39360	DDD WHL SMPL UG/L	WATER		1	.1500000			.150	.150	88/01/20	88/01/20
			K	22	.4320500	.2348300	.4845900	1.000	.002	74/01/07	89/01/18
			TOT	23	.4197800	.2276200	.4770900	1.000	.002	74/01/07	89/01/18
39363	DDD MUD UG/KG	WATER		1	6.000000			6.00	6.00	88/03/08	88/03/08
			K	17	16.55900	518.1200	22.76200	100.00	.002	78/11/07	89/01/18
			TOT	18	15.97200	493.8300	22.22200	100.00	.002	78/11/07	89/01/18
39365	DDE WHL SMPL UG/L	WATER	K	23	.4140900	.2315800	.4812200	1.000	.002	74/01/07	89/01/18
39368	DDE MUD UG/KG	WATER	K	18	15.69500	501.0900	22.38500	100.00	.002	78/11/07	89/01/18
39370	DDT WHL SMPL UG/L	WATER		1	1.300000			1.300	1.300	88/01/20	88/01/20
			K	23	.4645700	.2317100	.4813600	1.000	.002	74/01/07	89/01/18
			TOT	24	.4993800	.2507100	.5007100	1.300	.002	74/01/07	89/01/18
39373	DDT MUD UG/KG	WATER	K	18	29.91700	4648.200	68.17800	300.00	.002	78/11/07	89/01/18
39380	DIELDRIN TOTUG/L	WATER	K	24	.4397500	.2347600	.4845200	1.000	.002	74/01/07	89/01/18
39381	DIELDRIN DISUG/L	WATER	K	2	10.25000	190.1300	13.78900	20.000	.500	78/11/07	80/05/13
39383	DIELDRIN SEDUG/KG DRY WGT	WATER	K	18	15.69500	501.0900	22.38500	100.00	.002	78/11/07	89/01/18
39390	ENDRIN TOT UG/L	WATER	K	24	.4487100	.2277700	.4772500	1.000	.003	74/01/07	89/01/18
39393	ENDRIN SEDUG/KG DRY WGT	WATER	K	18	22.63900	2058.900	45.37600	200.00	.003	78/11/07	89/01/18
39400	TOXAPHEN TOTUG/L	WATER	K	23	.7239100	.1395200	.3735200	1.000	.050	75/07/01	89/01/18
39403	TOXAPHEN SEDUG/KG DRY WGT	WATER	K	17	286.8000	523530.0	723.5500	3000.00	.05	78/11/07	89/01/18
39410	HEPTCHLR TOTUG/L	WATER		2	1.025000	1.901300	1.378900	2.000	.050	74/01/07	77/07/12
			K	22	.4729600	.2431900	.4931400	1.000	.002	75/07/01	89/01/18
			TOT	24	.5189600	.3290000	.5735800	2.000	.002	74/01/07	89/01/18
39413	HEPTCHLR SEDUG/KG DRY WGT	WATER	K	18	15.69500	501.0900	22.38500	100.00	.003	78/11/07	89/01/18
39420	HPCHLREP TOTUG/L	WATER	K	24	.4589200	.2275600	.4770300	1.000	.002	74/01/07	89/01/18
39423	HPCHLREP SEDUG/KG DRY WGT	WATER	K	18	15.69500	501.0900	22.38500	100.00	.002	78/11/07	89/01/18
39480	MTHXYCLR WHL SMPL UG/L	WATER	K	21	.5890500	.2013100	.4486800	1.000	.010	74/01/07	89/01/18
39481	MTHXYCLR MUD DRY UG/KG	WATER	K	15	60.73400	15798.00	125.6900	500.00	.01	79/10/09	89/01/18
39488	PCB-1221 TOTUG/L	WATER	K	13	.6561500	.1544900	.3930600	1.000	.030	81/11/10	89/01/18
39491	PCB-1221 SEDUG/KG DRY WGT	WATER	K	10	416.0000	840090.0	916.5700	3000.00	.03	82/06/02	89/01/18
39492	PCB-1232 TOTUG/L	WATER	K	21	.7871400	.1219700	.3492500	1.000	.030	77/01/25	89/01/18
39495	PCB-1232 SEDUG/KG DRY WGT	WATER	K	18	236.9700	487200.0	698.0000	3000.00	.03	78/11/07	89/01/18
39496	PCB-1242 TOTUG/L	WATER	K	21	.7871400	.1219700	.3492500	1.000	.030	77/01/25	89/01/18
39499	PCB-1242 SEDUG/KG DRY WGT	WATER	K	18	236.9700	487200.0	698.0000	3000.00	.03	78/11/07	89/01/18
39500	PCB-1248 TOTUG/L	WATER	K	13	.6561500	.1544900	.3930600	1.000	.030	81/11/10	89/01/18

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39503 PCB-1248 SEDUG/KG DRY WGT	WATER	K	10	416.0000	840090.0	916.5700	3000.00	.03	82/06/02	89/01/18
39504 PCB-1254 TOTUG/L	WATER		1	7.000000			7.000	7.000	79/10/09	79/10/09
		K	20	.7765000	.1258900	.3548100	1.000	.030	77/01/25	89/01/18
		TOT	21	1.072900	1.964000	1.401400	7.000	.030	77/01/25	89/01/18
39507 PCB-1254 SEDUG/KG DRY WGT	WATER	K	18	236.9700	487200.0	698.0000	3000.00	.03	78/11/07	89/01/18
39508 PCB-1260 TOTUG/L	WATER		1	1.000000			1.000	1.000	77/01/25	77/01/25
		K	20	.7765000	.1258900	.3548100	1.000	.030	77/07/12	89/01/18
		TOT	21	.7871400	.1219700	.3492500	1.000	.030	77/01/25	89/01/18
39511 PCB-1260 SEDUG/KG DRY WGT	WATER	K	18	236.9700	487200.0	698.0000	3000.00	.03	78/11/07	89/01/18
39514 PCB-1016 SEDUG/KG DRY WGT	WATER	K	9	460.0000	923320.0	960.9000	3000.00	.03	83/05/10	89/01/18
39530 MALATHN WHL SMPL UG/L	WATER		1	.7000000			.700	.700	77/01/25	77/01/25
		K	15	1.471300	5.680800	2.383400	10.000	.020	75/07/01	89/01/18
		TOT	16	1.423100	5.339200	2.310700	10.000	.020	75/07/01	89/01/18
39531 MALATHN MUD UG/KG	WATER	K	14	172.5000	124260.0	352.5000	1000.00	.05	79/05/09	89/01/18
39540 PARATHN WHL SMPL UG/L	WATER	K	15	3.271300	17.74900	4.212900	10.000	.020	75/07/01	89/01/18
39541 PARATHN MUD UG/KG	WATER	K	14	879.6500	7014600	2648.500	10000.00	.05	79/05/09	89/01/18
39730 2,4-D WHL SMPL UG/L	WATER		1	1.700000			1.700	1.700	79/05/09	79/05/09
		K	13	3.696900	20.73600	4.553700	10.000	.010	81/11/10	89/01/18
		TOT	14	3.554300	19.42600	4.407400	10.000	.010	79/05/09	89/01/18
39731 2,4-D MUD UG/KG	WATER	K	12	105.4200	18569.00	136.2700	500.00	.05	81/11/01	89/01/18
39760 SILVEX WHL SMPL UG/L	WATER	K	13	3.208500	22.27000	4.719200	10.000	.010	81/11/10	89/01/18
39761 SILVEX MUD UG/KG	WATER	K	12	51.75100	2023.900	44.98800	100.00	.01	81/11/01	89/01/18
39780 DICOFOL WHL SMPL UG/L	WATER		1	8.500000			8.500	8.500	74/01/07	74/01/07
		K	8	.5381300	.2447700	.4947400	1.000	.005	75/07/01	80/10/14
		TOT	9	1.422800	7.257700	2.694000	8.500	.005	74/01/07	80/10/14
39782 LINDANE WHL SMPL UG/L	WATER	K	21	.4871000	.2513000	.5013000	1.000	.002	74/01/07	89/01/18
39783 LINDANE MUD DRY UG/KG	WATER	K	17	16.58800	517.1300	22.74100	100.00	.002	79/05/09	89/01/18
46570 CAL HARD CA MG MG/L	WATER	$	7	339.3400	11890.00	109.0400	489	130	66/07/07	86/10/13
70301 DISS SOL SUM MG/L	WATER		8	1100.300	739150.0	859.7400	2728	19	73/05/08	86/10/13
71850 NITRATE TOT-NO3 MG/L	WATER		183	15.03200	226.3300	15.04400	83.0	.0	66/07/07	92/02/05
		K	14	.3485700	.0472440	.2173600	.9	.04	73/09/17	84/07/16
		TOT	197	13.98900	224.4700	14.98200	83.0	.0	66/07/07	92/02/05
71885 IRON FE UG/L	WATER		8	601.2500	90498.00	300.8300	1270.00	330.00	74/01/07	84/05/14
71900 MERCURY HG,TOTAL UG/L	WATER		6	5.466700	26.12700	5.111400	13.5	1.0	73/07/16	82/06/01
		K	14	2.421400	26.78300	5.175300	20.0	.2	73/04/06	85/10/14
		TOT	20	3.335000	27.25100	5.220200	20.0	.2	73/04/06	85/10/14
71921 MERCURY SEDMG/KG DRY WGT	WATER		7	.2617100	.2583000	.5082300	1.4	.007	78/11/07	83/05/10
		K	7	.1785700	.0161810	.1272100	.4	.03	81/05/19	86/10/14
		TOT	14	.2201400	.1285500	.3585300	1.4	.007	78/11/07	86/10/14

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74041	WQF	SAMPLE	UPDATED	WATER		72	894040.0	2970E+05	17235.00	920526	860717	79/03/21	92/02/07
80101	CARBON	DRY WGT	MG/KG	WATER		3	3880.000	1469200	1212.100	4900.0	2540.0	83/11/08	86/10/14
81799	AVG.STRM	FLOW PER	COMP.CFS	WATER		13	30.93500	7228.600	85.02100	308	2	79/06/11	82/01/11
81886	PERTHANE	SED DRY	WGTUG/KG	WATER	K	10	136.0000	29560.00	171.9300	500.000	.003	81/11/01	89/01/18
82007	% SAND	IN SED	DRY WGT	WATER		5	63.64000	819.4600	28.62600	88.00	15.20	82/06/02	85/10/15
82008	SEDIMENT	PARTSIZE	SILT	WATER		5	29.32000	834.6100	28.89000	77.60	7.00	82/06/02	85/10/15
82009	SEDIMENT	PARTSIZE	CLAY	WATER		5	7.040000	10.00800	3.163600	11.00	3.00	82/06/02	85/10/15
82028	RATIO	FEC COL	FEC STRP	WATER	$	1	2.162800			2	2	75/10/07	75/10/07
82302	RADON222	TOT.CT.	ER PC/L	WATER		1	30.00000			30.00	30.00	85/10/15	85/10/15
82303	RADON222	TOTAL	PC/L	WATER		1	.0000000			.00	.00	85/10/15	85/10/15

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PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER	$	9	22.80900	1.309100	1.144200	25.0	21.5	75/05/01	85/09/04
00011	WATER	TEMP	FAHN	WATER		9	73.05600	4.250500	2.061700	77.0	70.7	75/05/01	85/09/04
00056	FLOW	RATE	GPD	WATER		37	8561.600	39258000	6265.700	26400	500	75/05/01	85/09/16
00310	BOD	5 DAY	MG/L	WATER		7	15.21400	166.1100	12.88800	39.0	6.0	75/05/01	82/03/18
00400	PH		SU	WATER		9	6.996700	.2001700	.4474000	7.50	6.10	75/05/01	85/09/04
00545	RESIDUE	SETTLBLE	ML/L	WATER		9	.0777780	.0019445	.0440960	.2	0	75/05/02	82/03/15
					K	46	.0521740	.0001063	.0103120	.1	.05	75/05/01	85/09/16
					TOT	55	.0563630	.0004680	.0216350	.2	0	75/05/01	85/09/16
00745	SULFIDE	TOTAL	MG/L	WATER	K	8	.2000000	.0000000	.0000000	.20	.20	75/05/01	85/09/04
72005	SAMPLE	SOURCE	CODE	WATER		11	1.000000	.0000000	.0000000	1	1	76/11/03	85/09/04
85001	BOD	5 DAY	#/DAY	WATER		7	1.733200	1.901300	1.378900	4	.5	75/05/01	82/03/18

B30 CA0002364004
33 45 44.0 118 05 50.0 2
ALAMITOS BARRIER PROJECT
06037 CALIFORNIA LOS ANGELES
140692

/TYPA/AMBNT/WELL

21CALAFD 18070106
0999 FEET DEPTH

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER	$	40	22.29000	.1080700	.3287500	23.0	21.7	75/02/13	78/08/23
00011	WATER	TEMP	FAHN	WATER		40	72.12300	.3493600	.5910700	73.4	71.0	75/02/13	78/08/23
00056	FLOW	RATE	GPD	WATER		40	288460.0	4848E+06	69631.00	387816	129550	75/02/13	78/08/23
00310	BOD	5 DAY	MG/L	WATER		19	.6710500	.8014800	.8952500	3.0	.0	75/02/13	78/07/13
00400	PH		SU	WATER		40	7.018200	.0629630	.2509300	7.50	6.60	75/02/13	78/08/23
00545	RESIDUE	SETTLBLE	ML/L	WATER	K	40	.0500000	.0000000	.0000000	.05	.05	75/02/13	78/08/23
00745	SULFIDE	TOTAL	MG/L	WATER	K	16	.2000000	.0000000	.0000000	.20	.20	75/02/13	78/07/13
72005	SAMPLE	SOURCE	CODE	WATER		41	1.000000	.0000000	.0000000	1	1	75/02/13	78/08/23
85001	BOD	5 DAY	#/DAY	WATER		19	1.327900	2.886000	1.698800	6	0	75/02/13	78/07/13

B320B CA0057231010
33 45 59.0 118 05 29.0 2
ALAMITOS BARRIER PROJECT
06037 CALIFORNIA LOS ANGELES
CALIFORNIA 140600
LOS ANGELES RIVER
21CALAFD 840225 HQ 18070106
0000 FEET DEPTH

/TYPA/AMBNT/WELL

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER	$	4	13.19500	1.929000	1.388900	15.0	11.7	85/02/27	86/04/03
00011	WATER	TEMP	FAHN	WATER		4	55.75000	6.250000	2.500000	59.0	53.0	85/02/27	86/04/03
00056	FLOW	RATE	GPD	WATER		15	25486.00	4100E+05	20251.00	55060	210	85/02/27	86/04/11
00400	PH		SU	WATER		4	7.600000	.0267490	.1635500	7.80	7.40	85/02/27	86/04/03
00545	RESIDUE	SETTLBLE	ML/L	WATER	K	36	.0500000	.0000000	.0000000	.05	.05	85/02/27	86/04/11
00745	SULFIDE	TOTAL	MG/L	WATER	K	1	.2000000			.20	.20	86/04/03	86/04/03
72005	SAMPLE	SOURCE	CODE	WATER		4	1.000000	.0000000	.0000000	1	1	85/02/27	86/04/03

B20 CA0002364003
33 46 00.0 118 05 50.0 2
ALAMITOS BARRIER PROJECT
06037 CALIFORNIA LOS ANGELES
140692

/TYPA/AMBNT/WELL

21CALAFD 18070105
0999 FEET DEPTH

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER	$	40	21.38600	.4044500	.6359600	22.2	18.2	74/09/07	78/08/23
00011	WATER	TEMP	FAHN	WATER		40	70.49500	1.301300	1.140700	72.0	64.8	74/09/07	78/08/23
00056	FLOW	RATE	GPD	WATER		39	335340.0	7884E+06	88794.00	407207	1751	74/09/07	78/08/23
00310	BOD	5 DAY	MG/L	WATER		20	.7400000	.9151600	.9566400	4.0	.0	74/09/07	78/07/13
00400	PH		SU	WATER		40	7.131000	.1200200	.3464400	8.60	6.60	74/09/07	78/08/23
00530	RESIDUE	TOT NFLT	MG/L	WATER		1	2.000000			2	2	74/09/07	74/09/07
00545	RESIDUE	SETTLBLE	ML/L	WATER		5	.0700000	.0045000	.0670820	.2	0	74/09/07	76/12/21
					K	36	.0500000	.0000000	.0000000	.05	.05	75/08/20	78/08/23
					TOT	41	.0524390	.0004939	.0222250	.2	0	74/09/07	78/08/23
00745	SULFIDE	TOTAL	MG/L	WATER	K	16	.2000000	.0000000	.0000000	.20	.20	75/06/13	78/07/13
72005	SAMPLE	SOURCE	CODE	WATER		39	1.000000	.0000000	.0000000	1	1	75/06/13	78/08/23
85001	BOD	5 DAY	#/DAY	WATER		20	1.808000	5.592500	2.364900	9	0	74/09/07	78/07/13
85002	SUSPNDED	SOLIDS	#/DAY	WATER		1	4.600000			5	5	74/09/07	74/09/07

B80 CA0057231004
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ALAMITOS BARRIER PROJECT
06037 CALIFORNIA LOS ANGELES
140692

/TYPA/AMBNT/WELL

21CALAFD 18070105
0999 FEET DEPTH

PARAMETER				MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER	$	9	21.24100	2.272000	1.507300	24.0	19.0	75/05/30	85/09/25
00011	WATER	TEMP	FAHN	WATER		9	70.23300	7.368700	2.714500	75.2	66.2	75/05/30	85/09/25
00056	FLOW	RATE	GPD	WATER		35	14417.00	1210E+05	11002.00	37650	940	75/05/23	85/10/01
00310	BOD	5 DAY	MG/L	WATER		7	10.85700	227.8100	15.09300	43.0	1.0	75/05/30	82/03/25
00400	PH		SU	WATER		9	7.404400	.0431820	.2078000	7.70	7.20	75/05/30	85/09/25
00545	RESIDUE	SETTLBLE	ML/L	WATER		18	.1022200	.0022301	.0472240	.2	.01	76/12/08	82/03/30
					K	35	.0557140	.0002605	.0161420	.1	.05	75/05/23	85/10/01
					TOT	53	.0715090	.0013939	.0373350	.2	.01	75/05/23	85/10/01
00745	SULFIDE	TOTAL	MG/L	WATER	K	8	.2000000	.0000000	.0000000	.20	.20	75/05/30	85/09/25
72005	SAMPLE	SOURCE	CODE	WATER		9	1.000000	.0000000	.0000000	1	1	76/12/21	85/10/01
85001	BOD	5 DAY	#/DAY	WATER		7	2.711300	15.71100	3.963700	11	.2	75/05/30	82/03/25

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

APR 08 1993

Mr. Don Kingery
CH2M HILL
1111 Broadway, Suite 1200
Oakland, CA 94607-4046

Dear Mr. Kingery:

Enclosed is the water quality data you requested from the STORET water quality data system. This retrieval summarizes the data by analytical constituent and monitoring site for the period of record.

If you have any questions or need more data, please contact me at (415) 744-1964.

Sincerely,

Eric Wilson

Eric Wilson
Computer Systems Analyst

Enclosures

References

Orange County Environmental Management Agency (OCEMA), Hydrologic Data Report, 1990-1991 Season, Volume XXVII, Environmental Resources Division, Santa Ana, CA

Soil Conservation Service (SCS) and Forest Service, Soil Survey of Orange County and Western Part of Riverside County, California, United States Department of Agriculture

Attachment A

Anaheim Bay Watershed Data Sources

Land Use

Land use maps -

City of Fountain Valley

Land Use Plan, Buena Park General Plan, Adopted by Resolution 7315 on March 15, 1982, Amended March 22, 1991 by Resolution 9268. From OCEMA/Flood Program Division

Department of Water Resources (DWR) land use maps corresponding to USGS topo maps for Seal Beach, Newport Beach, Anaheim, and Los Alamitos.

Topography

USGS 7-1/2' Topographic Maps -

Los Alamitos Quadrangle, 1965, photorevised in 1981

Anaheim Quadrangle, 1965, photorevised in 1981

Seal Beach Quadrangle, 1965, photorevised in 1981

Newport Beach Quadrangle, 1965, photorevised in 1981

Soils

Soil Survey of Orange County and Western Part of Riverside County, CA, United States Department of Agriculture, Soil Conservation Service and Forest Service

Watershed Hydrology

Hydrology Reports - (From Orange County Environmental Management Agency (OCEMA) Public Works)

Los Alamitos Channel Facility No. C01 and Los Alamitos Retarding Basin Facility No. C01B01. Prepared by Orange County Flood Control District. Includes description of drainage area, channels, 25- and 100-year discharge curves, Drainage Area Map, and Land Use and Soil Group Map.

Hydrology Report No. C02-4. Bolsa Chica Channel, Facility No. C02. San Diego Freeway to Cerritos Avenue.

Hydrology Report No. C00P02-2. Seal Beach Storm Drain, Facility No. C00P02

Hydrology Report No. C00PS1-2. Seal Beach Pump Station, Facility No. C00PS1

Hydrology Report No. C02-2. Bolsa Chica Channel, Facility No. C02, From Edinger Avenue to Huntley Avenue.

Hydrology Report No. C03-4. Anaheim-Barber City Channel, Facility No. C03, entire drainage system.

Hydrology Study, Westminster Channel, Facility No. C04, entire drainage area.

Hydrology Report for East Garden Grove-Wintersburg Channel (Facility No. C05), Bolsa Chica Bay to Vermont Avenue, Volume I, July 1990.

Hydrology Report No. C06-2, Ocean View Channel, Facility No. C06, entire drainage system, November 1989.

Hydrology Report No. C07-1, Sunset Channel, Facility No. C07, entire drainage system.

Draft EIS/EIR for the Proposed Bolsa Chica Project - Describes drainage and watershed for Bolsa Chica

Excepts from the 1990-1991 Hydrologic Data Report, OCEMA - Discharge summaries for 11 stream gaging stations, seasonal streamflow data for Westminster Channel station (No. 207), East Garden Grove-Wintersburg Channel (No. 217), Bolsa Chica Channel at Westminster (No. 225), and Anaheim-Barber City Channel (No. 232).

Stormwater Pollution Prevention Plan, Naval Weapons Station, Seal Beach, CA, October 1992.

Contaminant Source Evaluation

Environmental Protection Agency Storet System. Data retrieved from a query of the Storet System database for water quality samples within the Anaheim Bay Watershed. Contact: Eric Wilson, (415)744-1964.

Appendix B

EVALUATION OF SEDIMENT TRANSPORT IN THE SEAL BEACH NATIONAL WILDLIFE REFUGE

Appendix B

EVALUATION OF SEDIMENT TRANSPORT IN THE SEAL BEACH NATIONAL WILDLIFE REFUGE

Prepared by Don Kingery and Steve Costa

INTRODUCTION

Purpose

The evaluation of sediment transport in the Seal Beach National Wildlife Refuge (NWR) is a part of the National Wildlife Refuge Study to assess the impacts of the operations at Naval Weapons Station (NWS) Seal Beach on the NWR. The study assesses the impacts of operations of the NWS on biota of the NWR.

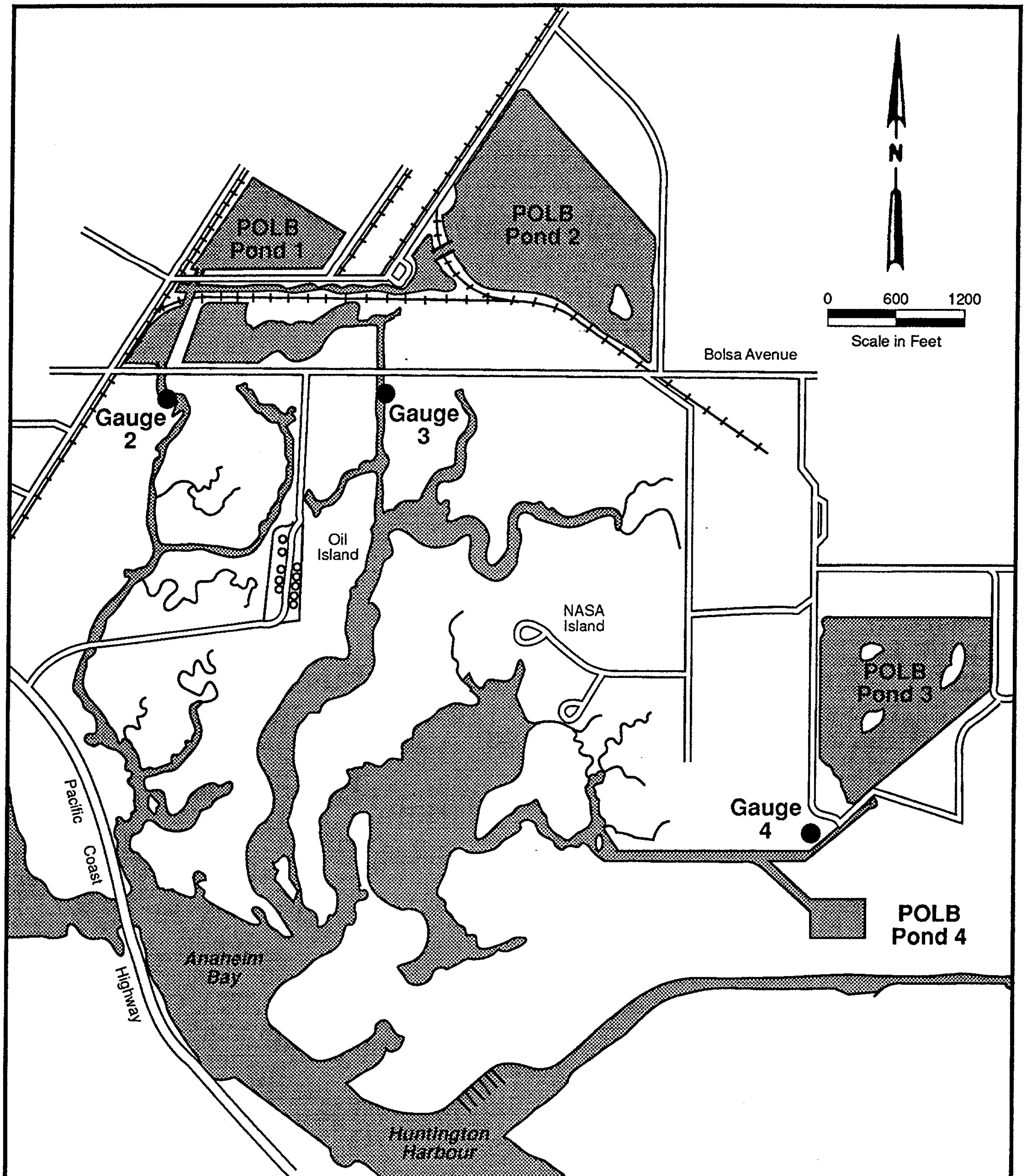
The primary objective of the sediment transport evaluation is to determine the contaminant transport potential within the tidal saltmarsh that comprises the NWR to provide a framework for evaluation of data obtained from sediment and biological sampling efforts. An evaluation of the transport mechanisms is important for assessing the potential sources, sinks, and transport paths of contaminants throughout the NWR. The results of the oceanographic studies provide a basis for more detailed and comprehensive investigations that may be required if additional sampling or feasibility studies (FSs) of potential corrective actions become necessary.

The oceanographic studies consist of physical oceanographic data collection, numerical modeling of the flow patterns and evaluation of contaminant transport mechanisms (including sediment transport potential) in the NWR.

Background

NWS Seal Beach occupies 5,000 acres adjacent to Anaheim Bay, approximately 26 miles south of the Los Angeles urban center. The 911-acre NWR, located within the NWS boundaries, is composed almost entirely of the remaining natural coastal saltmarsh of the once larger Anaheim Bay system. An Initial Assessment Study (IAS) conducted in 1985 and subsequent studies have identified potential past hazardous waste disposal sites and contaminated areas on the NWS that could pose a threat to the biota at the NWR. The presence of several special-status species and their dependence on the tidal saltmarsh of the NWR make the identification of contaminant levels at the NWR important.

Figure 1 shows the extent of the present tidal saltmarsh system in the NWR. Only a small portion of the tidal saltmarsh system occurs outside of the NWR boundaries, thus "NWR" and tidal saltmarsh" are used interchangeably to refer to this system. The Port of Long Beach (POLB) Ponds shown in Figure 1 are wetlands created by the POLB as mitigation for



● – Tidal Monitoring Stations

Figure 1
Seal Beach NWR Tidal Saltmarsh

mSCE70020.MN.ZZ Tidal 6/94

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the construction of a landfill in Long Beach Harbor. Construction began in 1989 and was completed in March and April 1990. These wetlands were constructed from areas of uplands and former wetlands, most of which had become isolated from tidal influences by roads or other barriers. The new wetlands consist of tidal basins with tidal channel connections and are part of the existing system.

Approach

The approach to evaluate the potential for sediment movement (and therefore, contaminant transport) throughout the NWR includes:

- o Evaluation of the physical processes of potential importance for contaminant transport in the tidal saltmarsh
- o Collection of physical oceanographic data through existing sources, as well as through field data collection, to define the physical characteristics of the tidal saltmarsh
- o Computer modeling of the hydrodynamics of the tidal saltmarsh system
- o Assessment of the sediment transport potential within the tidal saltmarsh based on the results of the computer model

The tasks listed above are sequential, with the results from one required for those that follow. The physical data collected were used as a basis for the development and calibration of the computer models of the tidal saltmarsh. The models were run for a number of tidal conditions in order determine the magnitudes of currents through the tidal channels. Similarly, the resulting current values were used to evaluate the potential for contaminant transport throughout the tidal saltmarsh.

PHYSICAL PROCESSES

Transport paths of contaminants entering the tidal saltmarsh are advection and diffusion for contaminants in the water column and sediment transport for contaminants bound to sediments. Both depend on water currents and circulation patterns. The levels and distribution of contaminants in the water column depend, in large part, on the rate of exchange of water between the tidal saltmarsh and Anaheim Bay. The flushing rates and residence times of each arm of the tidal saltmarsh are indicators of the potential to transport water-borne contaminants into and out of the tidal saltmarsh. The flushing rate is the rate at which water is removed from the area as a result of tidal exchange with the ocean or flows from runoff from the areas surrounding the tidal saltmarsh. The residence time is the time required to completely flush a volume of water (or a water-bourne contaminant) from the tidal saltmarsh and is a function of the flushing rate and the volume of the tidal saltmarsh.

For sediment bound contaminants, the current velocities in the tidal saltmarsh will determine the tendency of the sediments to erode or acrete.

The physical forces of potential importance for driving the currents in a basin or tidal saltmarsh are wind, waves, tides, and fresh water flows. Of these, tides are expected to be the most significant for the system in the NWR. The Anaheim Bay system is isolated from the effects of ocean waves, thus, they will not influence the currents in the tidal saltmarsh. The influence of wind also is not expected to be significant compared to tidal influences. The tidal saltmarsh largely consists of narrow meandering channels with relatively little surface area on which the wind may act. The circulation models employed in this study predict the response of the tidal saltmarsh to tidal influences.

DATA COLLECTION

Physical oceanographic data are required to describe the physical environment of the tidal saltmarsh in order to understand the sources, transport, and distribution of contaminants in the NWR. Data collected include water surface elevations (tidal data), bathymetry and dimensions of tidal saltmarsh channels, and salinity and velocity profiles at selected locations in the NWR. These data were used to evaluate the processes important to the transport of contaminants through the tidal saltmarsh and to develop and calibrate the numerical model used to predict water velocities and sediment transport potential in the NWR.

The salinity profiles were used to evaluate the characteristics of the flow in the tidal saltmarsh in order to determine the type of model required (i.e. the amount of stratification determines whether a single layer model can be used or whether a two-layer model is required). The bathymetry and channel dimensions were used to define the geometry of the model. Observed flow velocities and water surface elevation data were required primarily for calibration of the model against observed conditions.

Water Level Data

Four Flo-Tote water level gauge stations were installed to monitor tidal propagation in the NWR. The gauges were deployed from 2 December 1992 through 4 January 1993 and were set to take readings of the water surface elevation once every 10 minutes for a 30-second sampling interval. Gauges 2, 3, and 4 are shown in Figure 1. Gauge 1 was installed on a Navy Pier in Anaheim Bay, west of the Pacific Coast Highway to monitor the tidal elevations in Anaheim Bay (not shown in Figure 1). In addition, tide data at Newport Beach (Newport), approximately 10 miles from Anaheim Bay, were also obtained from National Oceanic and Atmospheric Administration (NOAA) for the month of December 1992.

A check of the gauges approximately 4 or 5 days into the recording period showed that the tide gauge installed on the Navy Pier in Anaheim Bay had stopped recording. The gauge was reprogrammed and redeployed and appeared to be operating properly for the remainder of the recording period. However, subsequent analysis of the data from this gauge indicated that data were not recorded accurately. The recorded mean water level drifted with time and recorded amplitudes appeared erratic and significantly lower than those from the other gauges. The data from this gauge, therefore, were discarded and tide data from the Newport gauge were used to characterize ocean tides in their place.

The observed amplitude and phase of the water surface fluctuations in each of the arms of the tidal saltmarsh relative to those at the tidal saltmarsh mouth (based on the Newport gauge data) were used in the model calibration, as described below. The data from the three gauges installed in the NWR were analyzed and compared with the water level data for Newport. Table 1 summarizes the mean tide ranges for each of the four data sets, as well as the average time lag between the high and low waters at Newport and those in the tidal saltmarsh. The Mean High Water (MHW) and the Mean Low Water (MLW) are averages of the maximum and minimum water surface elevations, respectively, for each tidal cycle in the data set relative to the mean sea level (msl) for the data set. The time lag or phase lag refers to the average difference in time between the high and low tides at the Newport station and the corresponding high and low tides at the tide gauges in the tidal saltmarsh. Attenuation is the reduction of the tidal amplitude between the Newport station and the tide gauges in the tidal saltmarsh. The time lag and attenuation are both functions of resistance to flow as a result of friction between the water and the channel bottom, as well as the geometry of the tidal saltmarsh. The data show little attenuation of tidal fluctuations for the middle and eastern arms of the tidal saltmarsh with slightly higher (approximately 10 percent) attenuation of the tidal range for the western arm. Similarly, the data show a slight phase lag for the middle and eastern arms compared with the Newport water levels with a slightly higher lag for the western arm.

Table 1
Seal Beach Tidal Range Summaries[a]

Gauge	MHW[b] (ft msl)	MLW[b] (ft msl)	Mean Range (ft)	Time Lag from Newport (minutes)[c]	Attenuation[d]
Newport	1.98	-1.65	3.63	---	---
Gauge 2	2.12	-1.16	3.28	+11.5	0.35 ft (9.6 percent)
Gauge 3	2.33	-1.19	3.52	+7.5	0.11 ft (3.0 percent)
Gauge 4	2.24	-1.33	3.57	+7.5	0.06 ft (1.7 percent)

Footnotes:
a Based on hourly tide data.
b Mean water levels are for the period from 12/3/93 through 12/31/93.
c Average time lags based on hourly reported water levels from the Newport Beach gauge and half hourly levels from the NWR gauges.
d Attenuation based on reduction from Newport range.

Bathymetry and Water Column data

The bathymetric and water column data collection required three site visits: a 1-day reconnaissance visit on 13 October 1992, a site visit from 30 October through 3 November

1992 for field data collection, and a third visit on 13 November 1992 to take flow measurements that could not be obtained during the second visit.

Bathymetry

Depths were measured along selected transects in the NWR. Continuous traces of the depths along each transect were recorded using a King Marine Model 1350 fathometer. Additionally, a marked pole was used as a backup to the fathometer and to take spot readings in areas that were too shallow for the fathometer to operate or in locations where eel grass interfered with the ability of the fathometer to read the bottom.

The accuracy of the fathometer was checked prior to data collection using the calibrated pole with a metal disk attached to the end as a target. The fathometer sensor was mounted off the side of an inflatable boat with the sensor head approximately 4 inches below the surface of the water.

Attachment 1 includes all bathymetric field data collected, including fathometer traces and field notes. The field notes supplement the fathometer traces and include spot measurements and water column temperature and salinity measurements.

Figures 2 through 4 show locations of transects and spot readings for the collected data. The bathymetric data used for the development of the numerical models are summarized in

Table 2. The table includes measured depths, depths adjusted to Mean Lower Low Water (MLLW), and estimates of other channel dimensions. (MLLW is a tidal datum commonly used from which to measure water surface elevations.) There are two tidal cycles during a tidal day. The lower of the two low water levels during a tidal day is called the Lower Low Water (LLW) and the higher is called the Higher Low Water (HLW). MLLW is the average of all Lower Low Water Levels.

Water Column Profile

Temperature, salinity, and current velocity were measured throughout the water column at selected locations. Temperature and salinity measurements were taken on 1 November 1992, along with the bathymetry data. The data were collected using a YSI CT meter. Readings at each location were taken near the surface and just off the bottom. Field data, including the recorded values and the locations of the readings, are included with the bathymetric data in the field notes in Attachment 1. Table 3 presents the measured temperature and salinity data, along with the corresponding density of the water.

Current measurements were taken on 13 November 1992 using a Price AA current meter. Readings were taken at locations near the mouths of each of the three arms of the tidal saltmarsh. Measurements at each location were taken at depths approximately 1-foot below the surface, 1-foot above the bottom, and at mid-depth. A summary of the current data is presented in Table 4.

Table 2

Summary of Bathymetric Data.

Transect No.	Estimated Arm Width (m) (a)	Estimated Channel Width (m) (b)	Est. Depth Outside Channel (c)	Max. Channel Depth (c)	Depth Outside Channel (MLLW) (d)	Channel Depth (MLLW) (d)
1	24	12	1.0	2.4	0.00	1.38
2	24	14	0.9	2.5	0.00	1.45
3	18	0	0.2	0.2	0.00	0.00
3a	15	0	0.6	0.6	0.00	0.00
3b	17	0	0.9	0.9	0.00	0.00
3c	24	0	1.1	1.1	0.04	0.04
4	17	6	0.6	1.2	0.00	0.18
5	17	6	0.6	1.2	0.00	0.12
6	24	12	0.6	2.5	0.00	1.49
7	38	23	0.6	2.5	0.00	1.47
8	34	13	1.1	3.8	0.05	2.67
9	34	15	1.1	3.8	0.00	2.73
9a	29	0	1.2	1.4	0.11	0.26
9b	29	0	1.5	1.5	0.41	0.41
9c	18	0	0.9	1.1	0.00	0.00
9d	38	0	1.2	1.2	0.10	0.10
10	76	27	2.2	3.8	1.10	2.63
11	23	12	1.4	2.0	0.19	0.80
12	34	26	0.9	1.1	0.00	0.00
13	61	27	0.6	2.5	0.00	1.32
14	52	24	1.2	3.1	0.00	1.92
15	76	43	1.4	2.5	0.13	1.30
16	94	41	1.1	2.7	0.00	1.44
16a	94	37	1.2	3.0	0.00	1.73
17	85	85	1.1	2.3	0.00	1.04
18	137	46	1.2	5.6	0.00	4..31
19	81	18	1.2	5.0	0.00	3.67
20	85	15	1.8	2.5	0.52	1.23
21	258	26	0.6	2.5	0.00	1.25
22	58	58	1.0	1.1	0.00	0.00
23	114	114	1.0	1.1	0.00	0.00
24	274	274	1.2	1.8	0.00	0.51
25	34	15	0.9	3.5	0.00	2.23
26a	23	23	2.4	2.5	1.24	1.34
26b	20	20	2.1	2.2	0.94	1.04
27	34	30	1.2	2.1	0.04	0.91
28a	14	14	1.4	1.4	0.23	0.23
28b	9	9	1.5	2.0	0.39	0.84
29a	34	17	0.9	2.5	0.00	1.43

(a) Based on aerial photos of the NWR.
(b) Based on field observations.
(c) Based on fathometer trace where possible. Spot readings were taken in areas too shallow for operation of the Fathometer or areas in which eel grass interfered with the trace. Fathometer readings include a 4-inch correction to account for the depth of the sensor.
(d) Adjusted to MLLW based on estimated tide during the time the data were collected.

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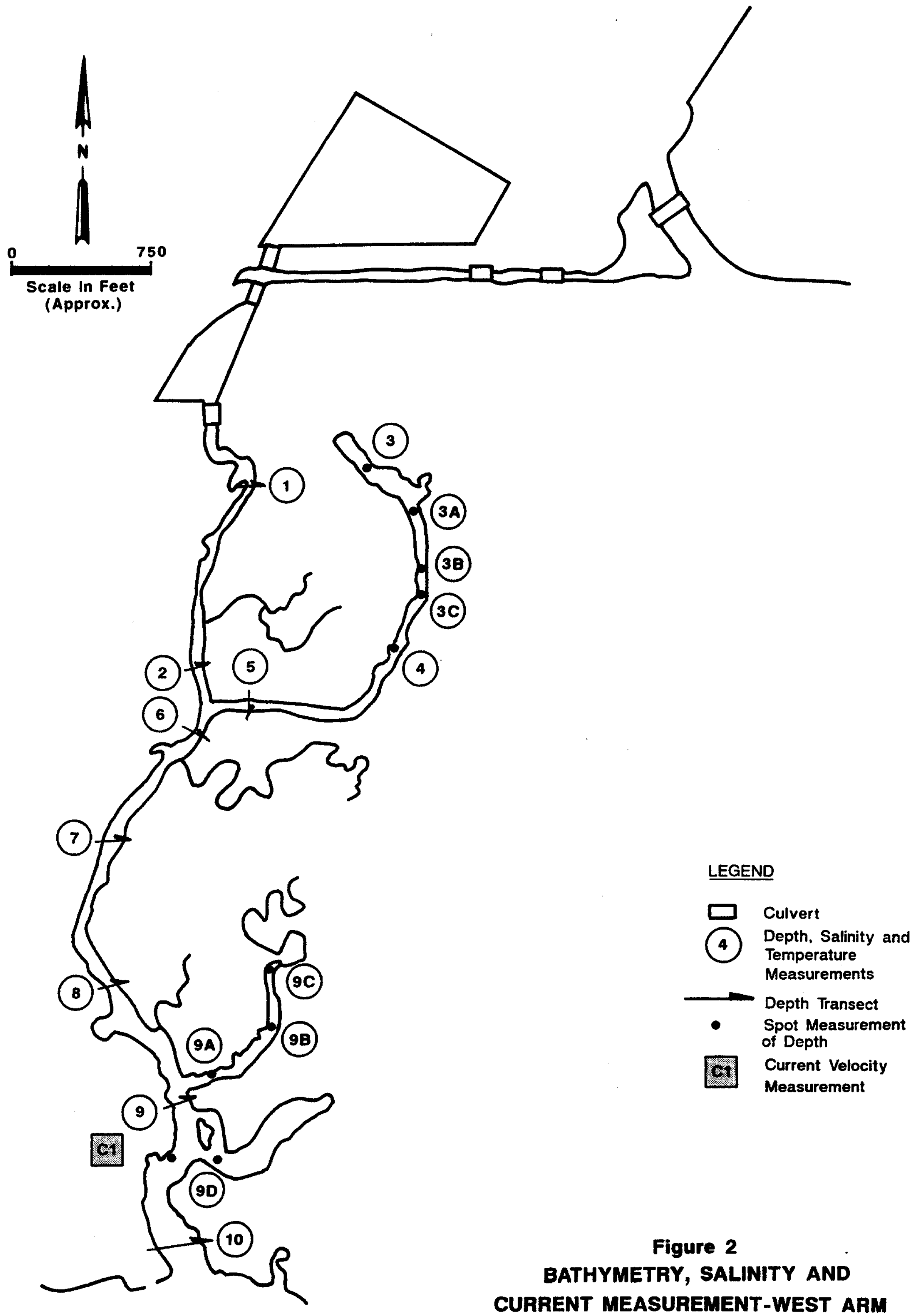

Figure 2
BATHYMETRY, SALINITY AND CURRENT MEASUREMENT-WEST ARM

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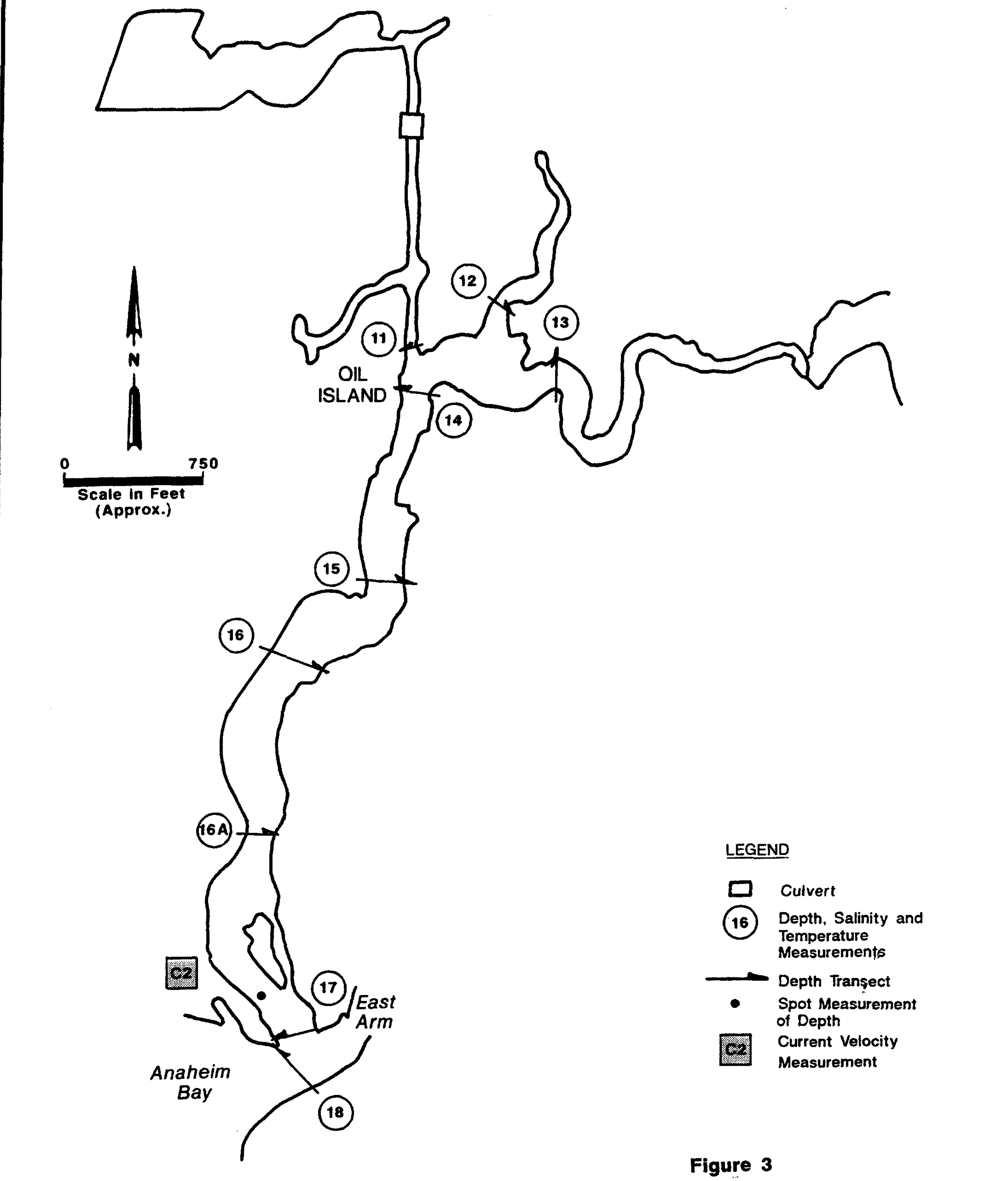

Figure 3
BATHYMETRY, SALINITY AND CURRENT MEASUREMENTS-MIDDLE ARM

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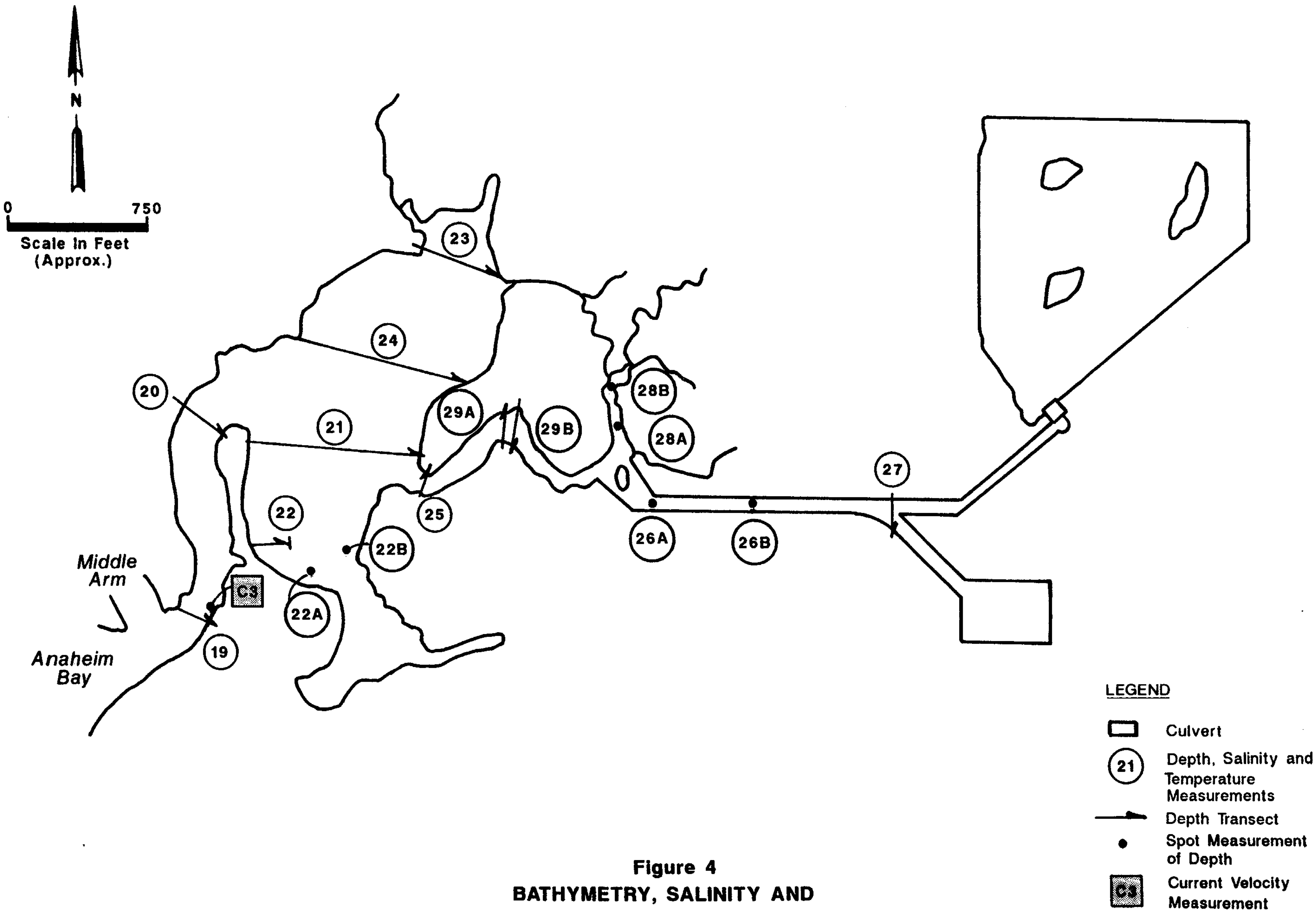

Figure 4
BATHYMETRY, SALINITY AND CURRENT MEASUREMENTS-EAST ARM

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Table 3
Seal Beach NWR Temperature and Salinty Data, 11/1/92
Page 1 of 2

Station	Time (PST)	Depth(1)	Temperature (°C)	Salinity	Density (gm/cm³)
1	8:20	S	19.0	28.5	1.020
		B	19.0	28.5	1.020
2	8:30	S	19.5	32	1.023
		B	19.5	32	1.023
3	8:57	M (8" deep)	18	32	1.023
4	9:12	S	18.5	32.5	1.023
		B	18.5	32.5	1.023
5	9:22	S	19.5	32	1.023
		B	19.5	32	1.023
6	9:34	S	19.5	32.25	1.023
		B	19.5	32.25	1.023
7	9:45	S	19.5	32.25	1.023
		B	19.5	32.25	1.023
10	10:30	S	20	31.5	1.022
		B	20	32.25	1.023
11	11:05	S	20.25	31.75	1.022
		B	20.75	31.75	1.022
12	11:15	S	20.5	32	1.022
		B	20.25	31.75	1.022
13	11:28	S	20.5	32	1.022
		B	20	31.75	1.022
15	11:48	S	20.75	31.25	1.022
		B	20.5	31	1.022
18	12:25	S	21.5	30.25	1.021
		B	21	31	1.022
20	13:55	S	21	31	1.022
		B	20.5	31	1.022
23	14:35	S	21.25	30.75	1.020
		B	20.5	31.5	1.022
25	15:00	S	21	31.75	1.022

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Table 3
Seal Beach NWR Temperature and Salinty Data, 11/1/92

Page 2 of 2

Station	Time (PST)	Depth(1)	Temperature (°C)	Salinity	Density (gm/cm³)
		B	20.75	31.5	1.022
27	15:20	S	21	32	1.022
		B	20.5	32	1.022
28	15:35	S	21	32	1.022
		B	21	32	1.022

(1) S = Surface, M = Mid-depth, B = Bottom

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Table 4
Seal Beach NWR Current Velocity Data, 11/13/92
Price AA Current Meter

Location	Channel Depth (ft)	Depth of Reading[1]	Speed (fps)	Time	Tidal Elevation & Phase
1 (Mouth of West Arm)	4	S	1.29	15:30	1.0 ft (ebb)
		M	1.33		
		B	1.09		
2 (Mouth of Middle Arm)	7	S	1.29	15:55	0.3 ft (ebb)
		M	1.22		
		B	0.95		
3 (Mouth of East Arm)	8	S	1.11	16:10	0.1 ft (ebb)
		M	1.36		
		B	1.11		

Footnotes:

1 S = Reading taken approximately 1 foot below surface
M = Reading taken at mid-depth
B = Reading taken approximately 1 foot off bottom

Tides during day of measurements:

Tide	Time (PST)	Height (ft)	
High Water	9:58	6.1	Tidal Range = 6.5 feet
Low Water	17:34	-0.4	

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CIRCULATION MODELING

Circulation Model Description

Formulation of the circulation model required several basic assumptions. The assumptions made for the NWR tidal saltmarsh system are:

- 1 Dimensional (1-D) Flow: The 1-D case assumes that the important variations in hydrodynamic and hydrographic parameters are along the alignment of the channel. Flow rates are taken as depth and cross-channel average values. No variation of the velocity with the vertical and cross-channel directions are accounted for in this type of model.

- Unstratified Flow: This assumption is reinforced by the temperature and salinity measurements taken during the field data collection efforts. The data show no difference between near-surface and near-bottom values of temperature and salinity for dry-weather periods.

- Bulk Formulation of Bottom Friction: Bottom friction is expressed as a nonlinear function of current speed with a constant friction coefficient. This assumption is not restrictive if model calibration is used to adjust the coefficient for the system under consideration.

These assumptions are implicit in the computer model "BCTCB," a model developed by CH2M HILL based on a finite difference numerical scheme presented by Koutitas (1988). BCTCB is a 1-D model (flow in the direction of the channel axis only) modified to model flow in tributary branches, as well as flow through the main channel of the tidal saltmarsh. The model solves depth averaged continuity and momentum equations to calculate the response of the channels to given water level (tidal) variations at their boundary. Output of water surface elevations and average current velocities at selected locations in the tidal saltmarsh provides the basis for sediment transport evaluation.

The depth averaged equations used to describe the system are:

$$\frac{\delta h}{\delta t}+\frac{\delta (UH)}{\delta x}=q \qquad \text{Eqn (1)}$$

for continuity and:

$$\frac{\delta U}{\delta t}+U\frac{\delta U}{\delta x}=-g\frac{\delta h}{\delta x}-\frac{\tau}{\sigma H} \qquad \text{Eqn (2)}$$

for momentum, where:

h = water surface elevation above still water datum

U = depth averaged, x-directed velocity

t = time

H = water depth below still water datum

q = introduced flow

x = distance along longitudinal axis

g = acceleration due to gravity

τ = boundary shear stress (friction)

σ = density

The boundary stress term is evaluated as:

$$\frac{\tau}{\sigma} = C_f U|U| \qquad \text{Eqn (3)}$$

where C_f is the friction coefficient.

The governing equations were approximated using an explicit finite difference scheme as described by Koutitas (1988), in which a forward difference is used for time derivatives and center differences are used for spatial derivatives.

This model was originally implemented to predict changes in the salinity structure of a creek that flows into San Francisco Bay (CH2M HILL, 1989). The program was modified by removing calculations of salinity and adding the ability to print elevation and current velocity results to ASCII files for plotting. The program listing is included as Attachment 2.

Model Definition

The model described above is capable of modeling a single 1-D main channel with a series of 1-D channels feeding into the main channel. As seen in Figure 1, the NWR tidal saltmarsh system contains three separate channels that come off of Anaheim Bay. As a result, three separate models were developed representing existing conditions (including POLB mitigation ponds) in each of the three main arms of the tidal saltmarsh. Two additional models were also run representing pre-POLB pond conditions for the east and west arms to assess possible changes associated with the addition of the ponds.

The channels are divided into cells, each with constant longitudinal dimensions. The cross-sectional area and channel width at the water surface are defined for each cell at MLLW and at Mean Higher High Water (MHHW). The model linearly interpolates to calculate these geometric parameters for water levels between MLLW and MHHW. Each model is defined based on data obtained from the oceanographic field data collection, as well as existing topographical maps and aerial photographs.

Figures 5 through 7 show the computational grids used to model the present configurations of the three arms of the NWR. A longitudinal cell length of 50 meters (m) was initially used for all models. Subsequently, the cell length for the west and east arm models were changed to 100 m in order to reduce computational time for these models. This change in cell size did not reduce accuracy of results. The model of the pre-POLB pond configuration of the west arm consists of the cells below the first culvert (cell 16 in Figure 5). Figure 8 shows the grid used to model the pre-POLB pond configuration of the east arm. The geometry of the channels for this configuration was determined from aerial photographs taken before the POLB ponds were constructed.

Calibration and Sensitivity

Calibration of the models was required to account for site-specific characteristics of the tidal saltmarsh. Calibration of this sort is primarily accomplished by adjusting the friction coefficient, C_f, defined in Eqn (3) above, until the hydraulic response of the tidal saltmarsh matches the observed response. The models representing the present conditions in the tidal saltmarsh were calibrated against observed currents from field measurements taken on 13 November 1992 and against water level data from the tidal data collected during December 1992. For each of the models, C_f was varied from 0.0025 to 0.05. The sensitivity of the models to changes in C_f is reflected in the results of the calibration model runs presented in Tables 5 and 6.

Tables 5 and 6 compare the results of these model runs with observed data. Table 5 presents observed velocities at the mouths of each arm, along with model results for various values of C_f. The bottom, mid-depth, and surface current measurements are presented, along with an average of the three measurements. Average velocities for the model cells at the locations of the current measurements or the cells surrounding the current measurement locations are shown for comparison with observed conditions.

The reduction or attenuation of the magnitude of the water surface changes between the mouth and the tide gauge location was used as a measure of the response of the tidal saltmarsh to tidal forcing. Tides were approximated in the model using sine curves. The tides are defined by specifying the amplitude (the vertical elevation difference between high tide and the following low tide), and the period (the time between two adjacent high tides). Because higher amplitude tides result in higher velocities and, therefore, higher resistance to flow, the attenuation for higher amplitude tides is greater than small amplitude tides. Three ranges of tides were modeled: a 1.5-foot amplitude, 9-hour tide for comparison with observed tides in the 1- to 2-foot range; a 3.6-foot amplitude, 12.4-hour tide for comparison with 3 to 4 foot observed tides; and a 6-foot amplitude, 14-hour tide for comparison with observed tides in the 5- to 7-foot range. Table 6 compares the modeled versus observed response of the water surface elevation at the locations of the tide gauges to various tidal conditions at the mouth of the tidal saltmarsh.

The potential for sediment movement in the tidal saltmarsh is directly related to the current velocities. If the current speed does not exceed a threshold value required to mobilize the sediment, there will be no significant sediment movement. The assessment of the potential for sediment movement in the tidal saltmarsh focuses on maximum expected velocities in the tidal saltmarsh. If the maximum expected velocity at a given location exceeds the

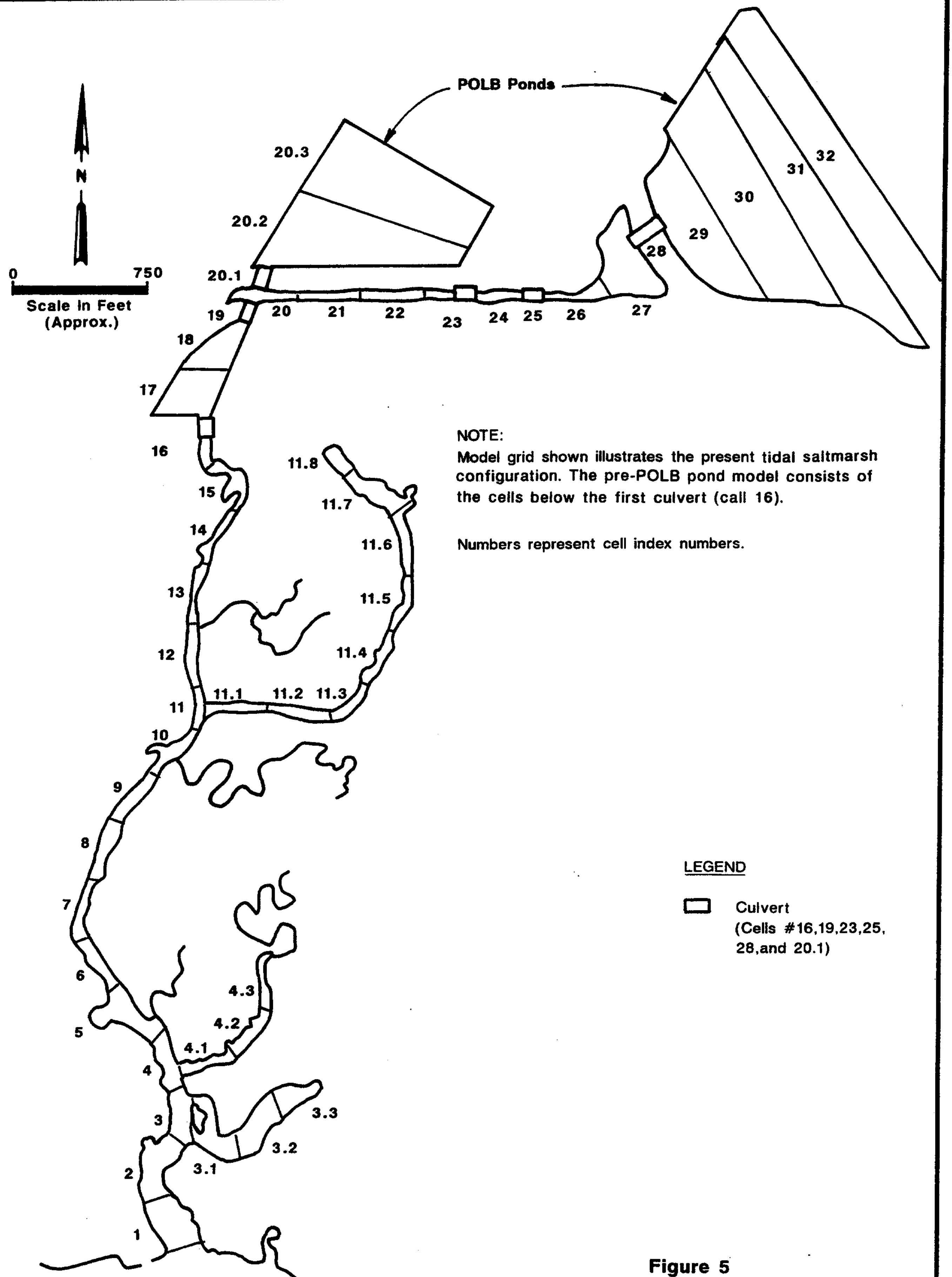

Figure 5
WEST ARM MODEL GRID

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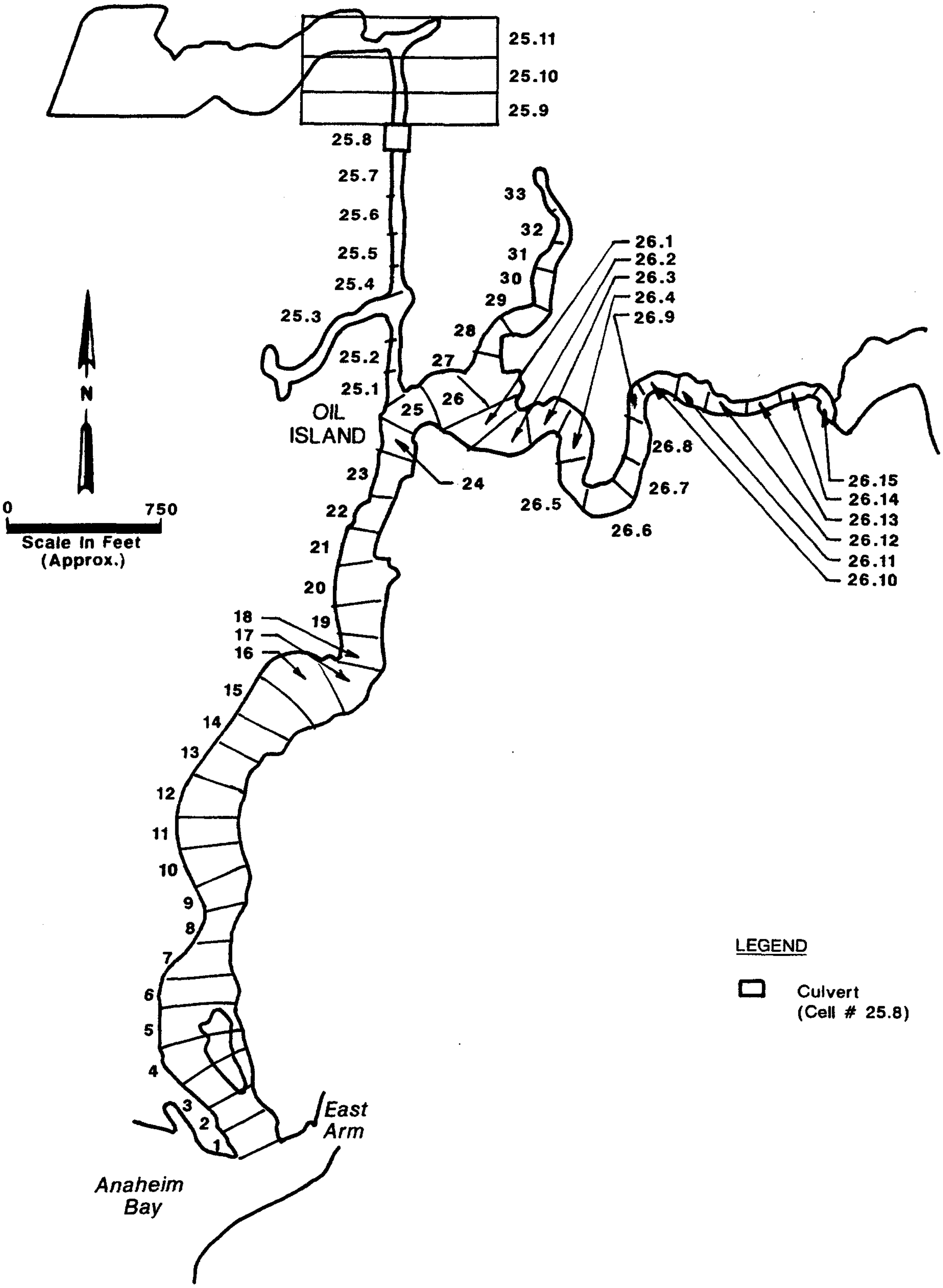

Figure 6
MIDDLE ARM MODEL GRID

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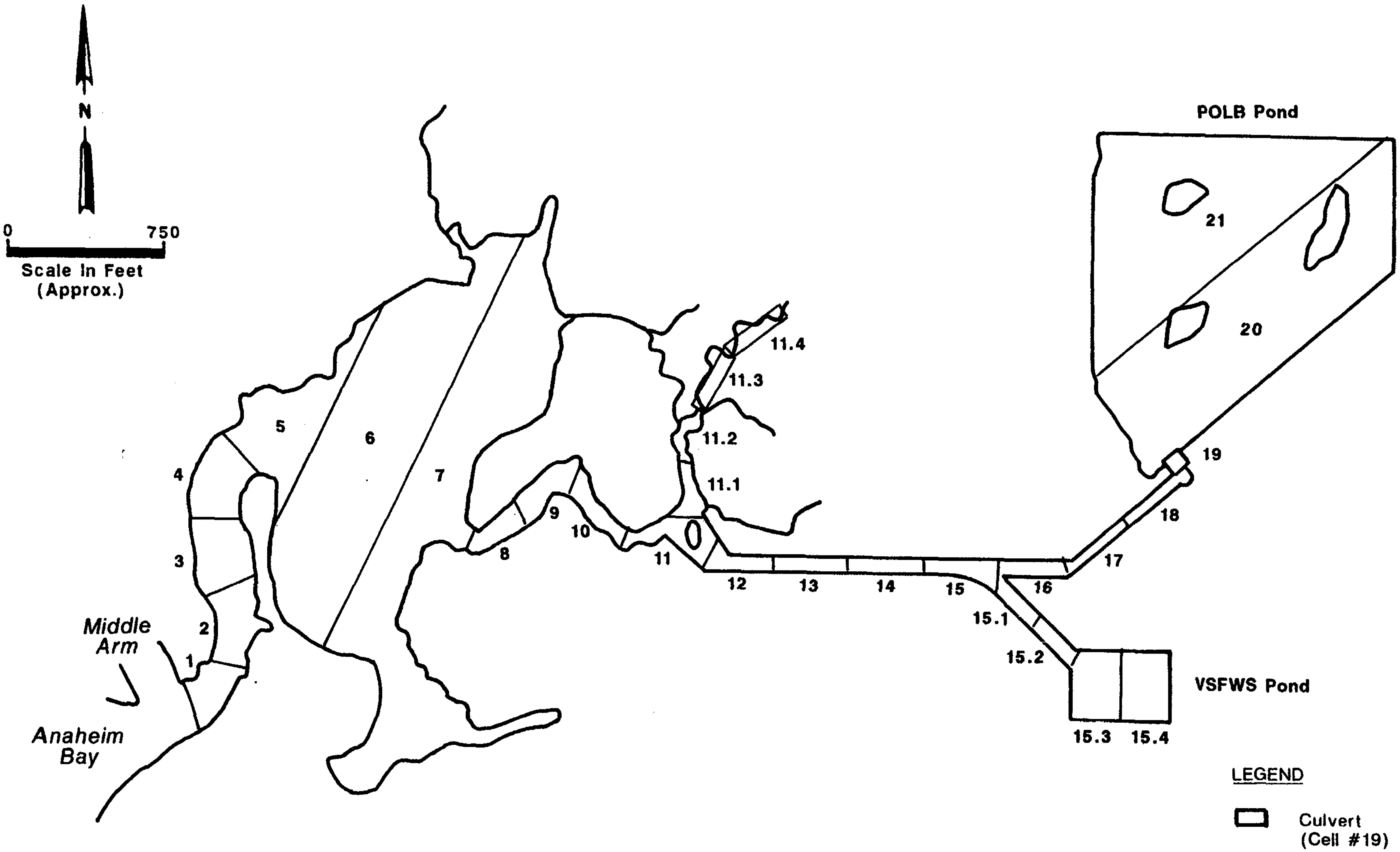

Figure 7
EAST ARM MODEL GRID
WITH
POLB PONDS

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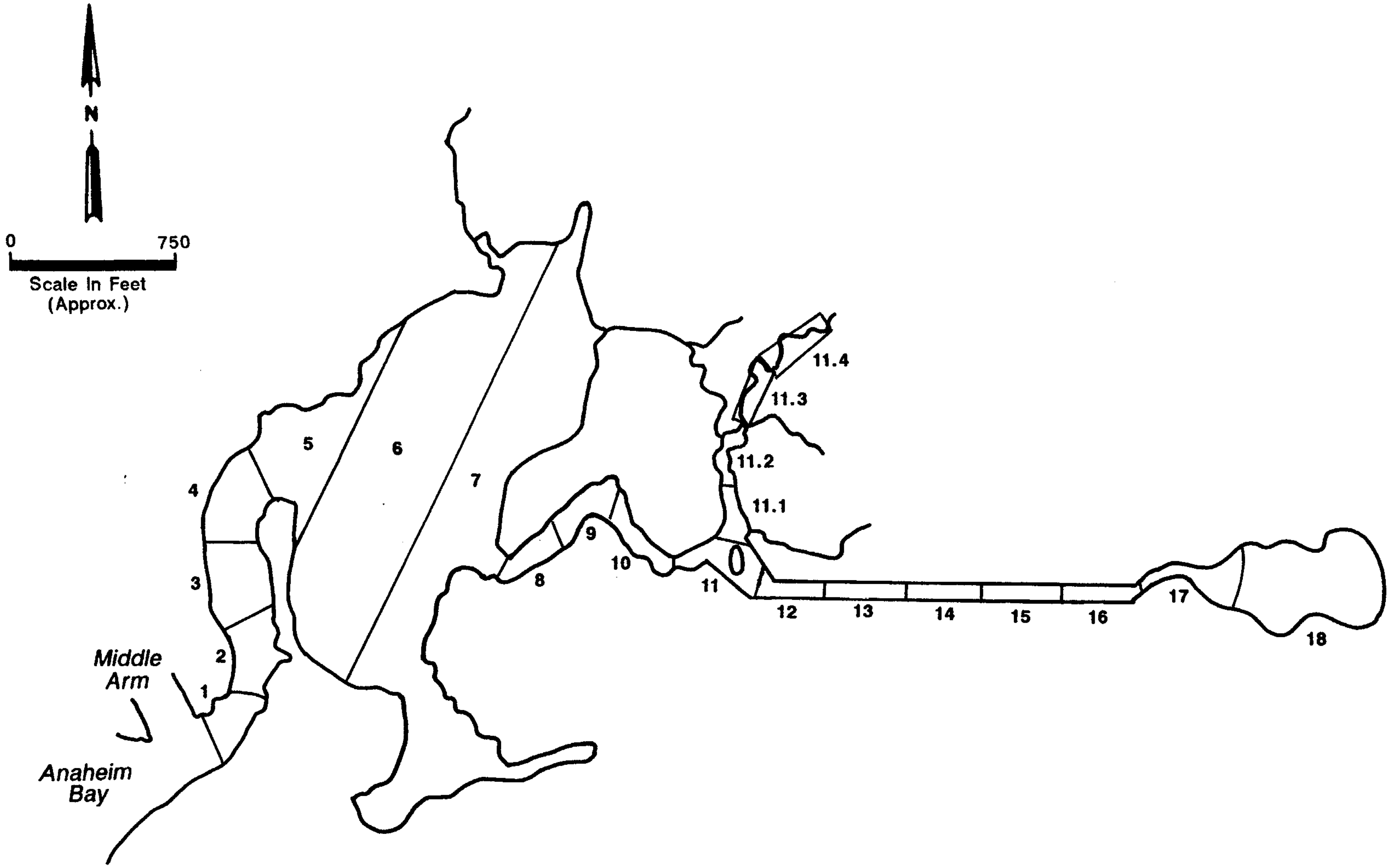

Figure 8
EAST ARM MODEL GRID
WITHOUT
POLB PONDS

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Table 5
Model Calibration, Modeled vs. Measured Current Velocities

C_f	Model Results [a]		Observed Current[b] (ft/sec)			
	Cell #	Velocity	B	M	S	Average
West Arm Model						
0.05	Cell 1 Cell 3	---	1.09	1.33	1.29	1.24
0.025	Cell 1 Cell 3	0.6 1.0				
0.0125	Cell 1 Cell 3	0.8 1.2				
0.00625	Cell 1 Cell 3	0.9 1.4				
0.0025	Cell 1 Cell 3	0.9 1.45				
Middle Arm Model						
0.05	Cell 1	0.89	.95	1.22	1.29	1.15
0.025	Cell 1	0.95				
0.0125	Cell 1	0.99				
0.00625	Cell 1	1.02				
0.0025	Cell 1	1.05				
East Arm Model						
0.05	Cell 1	---	1.11	1.36	1.11	1.19
0.025	Cell 1	1.20				
0.0125	Cell 1	1.22				
0.00625	Cell 1	1.27				
0.0025	Cell 1	1.30				

Footnotes:
a 15.2 hr, 3.25 ft sine wave tide input
b Current measurements taken 11/13/92.

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Table 6
Model Calibration, Modeled vs. Measured Tidal Attenuation

C_f	Attenuation (percent)					
	Low Amplitude[a]		Medium Amplitude[b]		High Amplitude[c]	
	Observed	Modeled	Observed	Modeled	Observed	Modeled
West Arm Model						
0.05	2.1	1.6	2.2	40.5	10.8	56
0.025		-.3		26		44
0.0125		-.3		12.5		31
0.00625		-.3		3.6		17
0.0025				0		
Middle Arm Model						
0.05	-3.0	-0.6	-1.4	-0.6	4.5	4.2
0.025		-0.6		-0.7		1.6
0.0125		-0.6		-0.6		0.1
0.00625		-0.8		-0.4		-0.6
0.0025		-1.5		-0.4		-0.9
East Arm Model						
0.05	-6.4	-0.9	-5.5	0.6	2.8	10.1
0.025		-0.8		-0.7		4.7
0.0125		-.7		-1		1.6
0.00625		-1.3		-1		-0.2
0.0025				-1		-1.2

Footnotes:
a Observed tides of 1 to 2 feet. Modeled sinusoidal tide at mouth of 1.5 feet with a 9 hour period.
b Observed tides of 3 to 4 feet. Modeled sinusoidal tide at mouth of 3.6 feet with a 12.4 hour period.
c Observed tides of 5 to 7 feet. Modeled sinusoidal tide at mouth of 6 feet with a 14 hour period.

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threshold for the sediment at that location, sediment movement will be expected. If the threshold is not exceeded at the maximum expected velocity, the potential for sediment movement will be low. Because sediment movement is dependent on maximum velocities, the critical parameters for sediment mobilization are velocities during high tidal range events. Therefore, selection of C_f for the models was made with an attempt to match both the high amplitude tidal attenuation and the observed current velocities.

Based on the results in Tables 5 and 6, the following values of C_f were used for the remainder of the model runs:

West Arm -	C_f =	0.0044
Middle Arm High -	C_f =	0.05
Middle Arm Low -	C_f =	0.0025
East Arm -	C_f =	0.019

For the middle arm model, a friction coefficient on the high end of the range was required to match the observed attenuation while a low coefficient was required to approach the observed velocity. For this model, both high friction and low friction models were run to give bounds for the velocities in the channels.

The friction coefficients shown above for the west and east arm models are used for both the models representing the present conditions, as well as the pre-POLB conditions.

Model Runs

The models were run for a tidal range at the mouth of the tidal saltmarsh of 8 feet with a 14-hour period, corresponding to the order of extreme events based on a review of the tidal predictions for Los Angeles, California in the National Ocean Service (NOS) tide tables (NOS, 1993). These tides were assumed to be sinusoidal and were run for a sufficient number of cycles so that any transients resulting from start-up of the model would damp out. The maximum velocities were extracted from the results of each model and are presented in Tables 7 through 12.

SEDIMENT TRANSPORT EVALUATION

Transport of sediment in the NWR tidal saltmarsh results from shear stresses acting on the bed material from fluid flow over the bed. As the velocity of flow over the bed increases, a threshold level is eventually reached. This threshold level is defined as the conditions at which sediment motion will be initiated.

Various factors, such as sediment and fluid density, size, shape, and profile of the bottom current, dictate at what point sediment motion will be initiated. Hjulström developed a simplified sediment threshold criterion to predict erosion, transport, and deposition of various size sediment grains based on average flow velocities (Graf, 1971). This

Table 7
Maximum Velocities in West Arm

Cell No.	Velocity (ft/sec)		Cell No.	Velocity (ft/sec)	
	ebb	flood		ebb	flood
Main Channel			Main Channel		
1	-2.61	1.33	28 (c)	-0.25	0.28
2	-2.60	1.33	29 (P)	-0.13	0.15
3	-3.98	1.93	30 (P)	-0.04	0.04
4	-4.51	2.61	31 (P)	-0.01	0.02
5	-4.26	2.90	32 (P)	0.00	0.00
6	-4.16	3.05	Branch at Cell 3		
7	-4.49	3.49	1	-0.79	0.17
8	-4.47	3.96	2	-0.29	0.14
9	-4.48	4.77	3	0.00	0.00
10	-5.27	6.03	Branch at Cell 4		
11	-5.14	6.79	1	-0.69	0.16
12	-3.87	5.59	2	-0.26	0.08
13	-4.22	6.18	3	0.00	0.00
14	-4.84	8.99	Branch at Cell 11		
15	-3.92	8.76	1	-0.42	0.51
16 (c)	-4.41	11.96	2	-0.34	0.41
17	-0.79	2.26	3	-0.28	0.36
18	-0.33	0.42	4	-0.23	0.28
19 (c)	-0.78	0.84	5	-0.15	0.17
20	-2.01	2.26	6	-0.10	0.10
21	-0.91	1.10	7	-0.05	0.05
22	-0.90	1.04	8	0.00	0.00
23 (c)	-1.54	1.78	Branch at Cell 20		
24	-1.53	1.82	1 (c)	-0.31	0.33
25 (c)	-1.38	1.66	2 (P)	-0.09	0.10
26	-1.41	1.76	3 (P)	-0.02	0.02
27	-0.33	0.41	4 (P)	0.00	0.00

Footnotes:
(c) = Culvert
(P) = POLB Pond

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Table 8
Maximum Velocities in Middle Arm - Low Friction Model

Cell No.	Velocity (ft/sec)		Cell No.	Velocity (ft/sec)	
	ebb	flood		ebb	flood
Main Channel			Main Channel		
1	-1.81	2.02	32	-0.14	0.24
2	-1.76	1.99	33	0.00	0.00
3	-2.48	2.83	Branch at Cell 25		
4	-1.90	2.31	1	-0.99	1.96
5	-1.43	1.79	2	-1.52	3.26
6	-1.18	1.53	3	-0.69	1.06
7	-1.04	1.38	4	-0.73	0.84
8	-1.05	1.42	5	-0.92	1.64
9	-1.19	1.63	6	-0.92	1.97
10	-1.28	1.77	7	-0.83	2.10
11	-1.26	1.73	8 (c)	-1.03	1.44
12	-1.23	1.75	9 (B)	-0.08	0.17
13	-1.27	1.82	10 (B)	-0.06	0.18
14	-1.28	1.79	11 (B)	0.00	0.00
15	-1.28	1.71	Branch at Cell 26		
16	-1.25	1.65	1	-0.14	0.21
17	-1.12	1.54	2	-0.09	0.14
18	-1.19	1.69	3	-0.13	0.22
19	-1.04	1.65	4	-0.15	0.25
20	-1.01	1.51	5	-0.17	0.29
21	-0.95	1.61	6	-0.18	0.32
22	-1.15	1.99	7	-0.18	0.33
23	-1.12	1.98	8	-0.22	0.43
24	-1.14	2.02	9	-0.36	0.55
25	-1.21	2.19	10	-0.47	0.78
26	-0.47	0.72	11	-0.41	0.71
27	-0.24	0.41	12	-0.40	0.86
28	-0.53	0.78	13	-0.35	0.71
29	-0.55	1.16	14	-0.22	0.46
30	-0.336	0.93	15	0.00	0.00
31	-0.25	0.36			

Footnotes:
(c) = Culvert
(B) = Bolsa Cell

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Table 9
Maximum Velocities in Middle Arm - High Friction

Cell No.	Velocity (ft/sec)		Cell No.	Velocity (ft/sec)	
	ebb	flood		ebb	flood
Main Channel			Main Channel		
1	-1.31	1.10	32	-0.04	0.08
2	-1.26	1.09	33	0.00	0.00
3	-1.56	1.36	Branch at Cell 25		
4	-1.14	1.10	1	-0.67	1.10
5	-0.86	0.87	2	-1.07	1.86
6	-0.72	0.76	3	-0.28	0.51
7	-0.64	0.70	4	-0.23	0.42
8	-0.65	0.72	5	-0.51	0.92
9	-0.73	0.82	6	-0.60	1.10
10	-0.77	0.88	7	-0.59	1.11
11	-0.74	0.85	8 (c)	-0.84	1.52
12	-0.73	0.87	9 (B)	-0.05	0.11
13	-0.75	0.91	10 (B)	-0.02	0.03
14	-0.70	0.86	11 (B)	0.00	0.00
15	-0.62	0.75	Branch at Cell 26		
16	-0.57	0.69	1	-0.08	0.14
17	-0.59	0.72	2	-0.07	0.11
18	-0.65	0.86	3	-0.10	0.16
19	-0.62	0.85	4	-0.11	0.18
20	-0.55	0.76	5	-0.11	0.20
21	-0.61	0.86	6	-0.12	0.20
22	-0.79	1.17	7	-0.11	0.18
23	-0.75	1.14	8	-0.12	0.21
24	-0.72	1.11	9	-0.11	0.20
25	-0.74	1.17	10	-0.10	0.20
26	-0.20	0.42	11	-0.08	0.15
27	-0.08	0.20	12	-0.07	0.13
28	-0.12	0.29	13	-0.07	0.13
29	-0.12	0.28	14	-0.04	0.08
30	-0.09	0.19	15	0.00	0.00
31	-0.06	0.14			

Footnotes:
(B) = Bolsa Cell
(c) = Culvert

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Table 10
Maximum Velocities in East Arm

Cell No.	Velocity (ft/sec)		Cell No.	Velocity (ft/sec)	
	ebb	flood		ebb	flood
Main Channel			Main Channel		
1	-1.85	1.47	17 (ch)	-1.01	2.29
2	-1.83	1.45	18 (ch)	-0.99	2.32
3	-1.51	1.33	19 (c)	-1.93	5.02
4	-1.32	1.20	20 (P)	-0.07	0.20
5	-0.53	0.69	21 (P)	-0.00	0.00
6	-0.34	0.25	Branch at Cell 11		
7	-0.37	0.15	1	-0.07	0.10
8	-1.26	0.46	2	-0.11	0.18
9	-2.57	2.34	3	-0.04	0.07
10	-2.04	2.28	4	0.00	0.00
11	-1.56	2.13	Branch at Cell 15		
12 (ch)	-1.32	2.12	1	-0.20	0.32
13 (ch)	-1.41	2.35	2	-0.30	0.55
14 (ch)	-1.52	2.63	3 (FW)	-0.06	0.10
15 (ch)	-1.41	2.56	4 (FW)	0.00	0.00
16 (ch)	-0.95	2.07			

Footnotes:
(ch) = Channel
(c) = Culvert
(P) = POLB pond
(FW) = USFWS pond

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Table 11
Maximum Velocities in West Arm (pre-POLB ponds)

Cell No.	Velocity (ft/sec) ebb	Velocity (ft/sec) flood	Cell No.	Velocity (ft/sec) ebb	Velocity (ft/sec) flood
Main Channel			Branch at Cell 3		
1	-1.05	1.03	1	-0.55	0.49
2	-1.02	1.00	2	-0.26	0.25
3	-1.34	1.34	3	0.00	0.00
4	-1.34	1.39	Branch at Cell 4		
5	-0.99	1.06	1	-0.48	0.44
6	-0.93	0.99	2	-0.23	0.22
7	-1.02	1.07	3	0.00	0.00
8	-1.07	1.14	Branch at Cell 11		
9	-1.17	1.26	1	-0.48	0.55
10	-1.25	1.39	2	-0.45	0.51
11	-1.12	1.34	3	-0.36	0.43
12	-0.35	0.42	4	-0.25	0.30
13	-0.16	0.17	5	-0.16	0.18
14	-0.07	0.08	6	-0.10	0.11
15	0.00	0.00	7	-0.05	0.06
			8	0.00	0.00

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Table 12
Maximum Velocities in East Arm (pre-POLB ponds)

Cell No.	Velocity (ft/sec)		Cell No.	Velocity (ft/sec)	
	ebb	flood		ebb	flood
Main Channel			Main Channel		
1	-0.52	0.52	13 (ch)	-0.19	0.19
2	-0.50	0.50	14 (ch)	-0.18	0.18
3	-0.45	0.45	15 (ch)	-0.17	0.17
4	-0.39	0.39	16 (ch)	-0.15	0.15
5	-0.21	0.21	17 (p)	-0.04	0.04
6	-0.08	0.07	18 (p)	0.00	0.00
7	-0.03	0.03	Branch at Cell 11		
8	-0.05	0.05	1	-0.05	0.05
9	-0.24	0.24	2	-0.07	0.07
10	-0.21	0.21	3	-0.03	0.03
11	-0.16	0.16	4	0.00	0.00
12 (ch)	-0.07	0.07			

Footnotes:
(ch) = Channel
(p) = POLB pond

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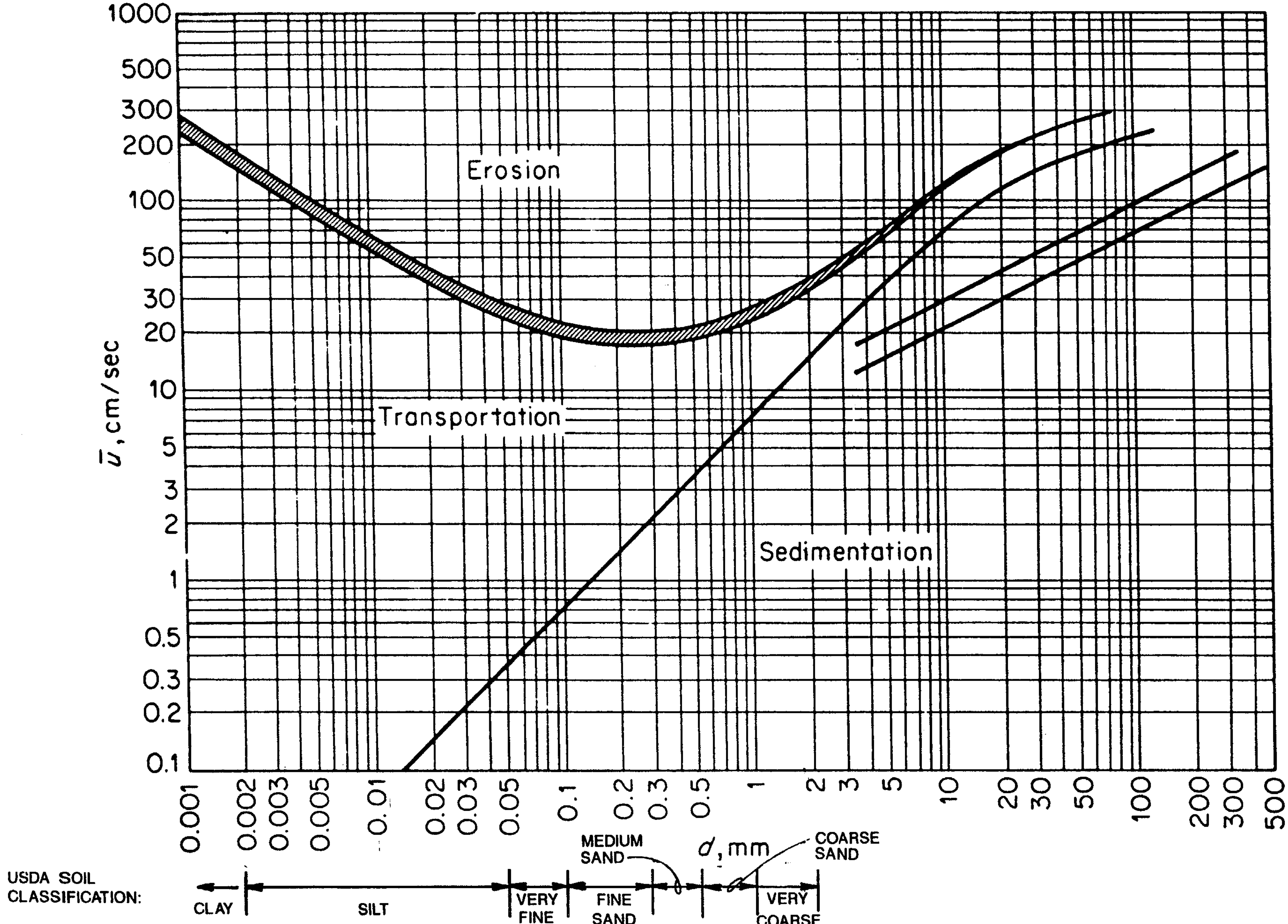

Figure 9

HJULSTROM DIAGRAM

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relationship is shown in Figure 9. This criterion indicates that uncohesive, fine and medium sand is most easily eroded, but that cohesion tends to bind smaller clay and silt size particles together to resist erosive forces. Once mobilized, however, the smaller sediments will stay in motion under the influence of smaller current velocities. In other words, sand-sized particles would be most easily mobilized as the current velocity increases and the first to settle out as the currents decrease.

An empirical relation for the threshold of sand-sized material was presented by Costa and Isaacs (1977) and has been applied to tidal flows by Stauble et al. (1987, 1988), Bhogal (1989), and Bhogal and Costa (1989). This criterion relates the critical velocity, depth of flow, and sand grain size and is given by:

where

V_C = the critical mean velocity (ft/sec)

D = the depth of flow (ft)

g = the median grain size

K = 1.168

a = 0.1

b = 0.4

$$V_c = K(D)^a(g)^b \qquad \text{Eqn } \mathbf{(4)}$$

K, a, and b are empirical constants determined by using field and flume data. This relationship was derived for a range of grain sizes from about 0.1 to 0.9 millimeters (mm).

The above relations are used as the basis of the sediment deposition/erosion analysis for the NWR tidal saltmarsh. The results of the analysis of sediment samples collected from the tidal saltmarsh are used to define the characteristics of the sediment. The results of the hydrodynamic model provide information on flows throughout the tidal saltmarsh.

Sediment Characteristics

Sediment samples were collected at the locations shown in Figure 10. The samples were analyzed for chemical content and grain size. As discussed above, the grain size distribution determines the ability of the sediment transport mechanisms to transport material. A summary of the results of the grain size analyses is shown in Table 13. The analysis results indicate that approximately 40 percent of the surface sediments in the tidal saltmarsh are sand-sized, with most of the remaining sediments in the silt and clay range.

The U.S. Department of Agriculture defines these classifications based on grain size as follows:

Table 13
Seal Beach Sediment Grain Size Analysis

Sample No.	Location (a)	% Sand	% Silt	% Clay
1	W	5.3	63.1	31.6
2	W	23.4	26.0	50.6
4	W	37.8	47.1	15.2
5	W	4.8	82.6	12.7
8	W	64.1	22.1	13.8
11	W	55.3	28.2	16.5
12	W	72.2	14.7	13.2
15	W	74.6	19.0	6.4
24	W	5.9	62.7	31.4
25	W	55.5	41.5	3.0
Average:		39.3	40.7	19.4
3	M	75.1	3.0	21.9
6	M	6.0	56.8	37.4
7	M	15.8	72.8	11.4
9	M	38.1	32.2	29.8
10	M	15.1	53.3	31.6
13	M	42.3	40.2	17.6
16	M	62.4	31.4	6.3
21	M	81.2	15.1	3.8
28	M	28.5	38.1	33.4
29	M	41.9	36.2	21.9
Average:		40.6	37.9	21.5
14	E	10.7	66.5	22.9
17	E	82.5	14.0	3.5
18	E	31.9	43.2	24.9
19	E	70.8	23.7	5.5
22	E	31.9	45.4	22.7
26	E	3.8	89.8	6.4
27	E	53.3	46.7	0.0
Average:		40.7	47.0	12.3
20	AB	29.5	32.9	37.6
23	AB	89.6	8.9	1.5
Average:		59.5	20.9	19.6

(a) W = West Arm
M = Middle Arm
E = East Arm
AB = Anaheim Bay

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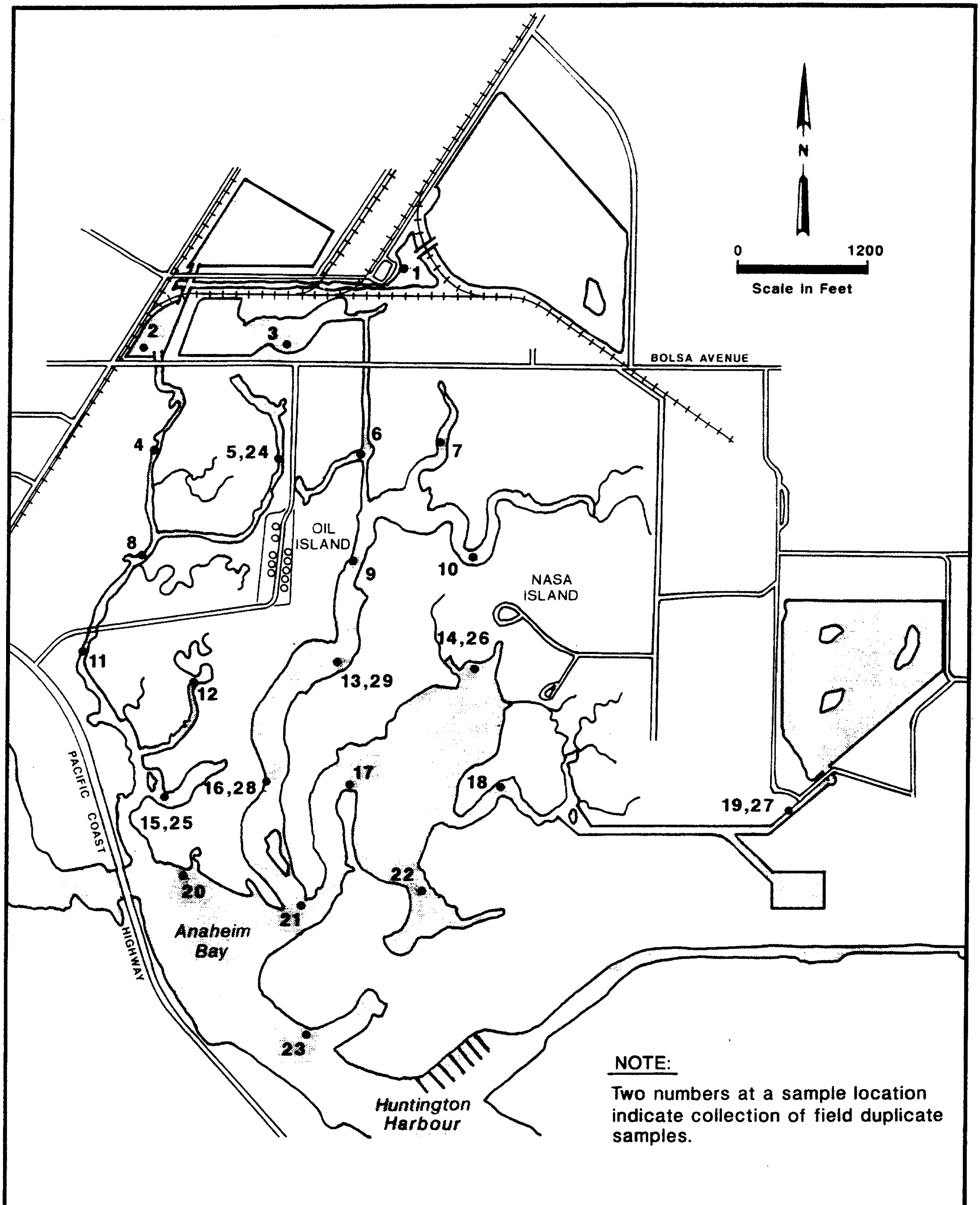

Figure 10
SEDIMENT SAMPLE LOCATIONS

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Classification	Grain Size, mm
Sand	
Very Coarse	1 to 2 mm
Coarse	0.5 to 1 mm
Medium	0.25 to 0.5 mm
Fine	0.1 to 0.25 mm
Very Fine	0.05 to 0.1 mm
Silt	0.05 to 0.002 mm
Clay	< 0.002 mm

Deposition/Erosion Analysis

Typically, the median grain size is used to evaluate the tendency of the sediment to be mobilized and/or transported. Analysis performed on the sediment samples by Geochemical and Environmental Research Group (GERG) provided a range of grain sizes in the NWR sediment (e.g., clay, silt, sand, etc.).

Based on the Hjulström diagram, the velocity required to mobilize sediment with median grain sizes in the sand range can vary from about 18 to 40 cm/sec (0.6-1.3 ft/sec) depending on the value of the median grain size. Current velocities for mobilization of sediment with median sizes in the silt range can range from about 25 to 190 cm/sec (0.8 to 6.2 ft/sec) depending on the value of the median grain size. Similarly, threshold velocities for deposition of suspended sediments range from about 0.38 to 15 cm/sec (1.012 to 0.5 ft/sec) for silt-sized sediments. These ranges of current velocities make identification of areas with the potential for sediment mobilization and deposition along each branch of the tidal saltmarsh approximate, only.

General observations can be made from the available data. A comparison of the grain size data in Table 13 with the sample points shown on Figure 10 indicates that the sediments generally have a greater fraction of sand-sized particles closer to the mouths and in the main channels of the three arms and a greater fraction of silt-sized particles at points further into the tidal saltmarsh and off of the main channel. This general distribution is related to current velocities at which particles with different grain sizes are deposited. As seen in Figure 9, the velocity that particles start to deposit as bottom sediments decreases with sediment particle size. The flow in the tidal saltmarsh decreases with distance from the mouth up the tidal saltmarsh and into the branches. The larger particles are expected to be deposited first closer to the mouth and the smaller particles deposited further into the tidal saltmarsh where velocities are generally lower. This is the general pattern seen from the grain size evaluation.

The following approach was taken for evaluating the erosion/deposition tendencies for the tidal saltmarsh:

- Calculation of the threshold current velocity for the most easily mobilized grain size (i.e. fine sand) using Equation (4)

- Evaluation of required current velocities for mobilizing grain sizes in the silt range using the Hjulström diagram (Figure 9)

- Evaluation of velocities that result in deposition of the above grain sizes based on the Hjulström diagram

- Comparison of current velocities required for erosion and deposition with the maximum current velocities calculated by the hydraulic model presented above

- Identification of areas of the tidal saltmarsh that are prone to erosion or deposition

Threshold Velocities for Sand

Equation (4) calculates the threshold velocity as a function of grain size and water depth. For a given grain size, the critical threshold velocity is a function of the water depth only. Table 14 presents the threshold velocity for sand with a median grain size of 0.1 mm. The variation with depth is relatively small, and the depths throughout the tidal saltmarsh are typically on the range of 1 to 15 feet for threshold velocities for 0.1 mm diameter sand of about 0.5 to 0.6 ft/sec. The velocities in Table 14 assume a median grain size of 0.1 mm. For sediments that are predominantly clay or silt, the threshold velocities will be higher.

Table 14
Threshold Velocity for 0.1 mm Diameter Grain Size Sediment

Water Depth (ft)	Threshold Velocity (ft/sec)
1	0.47
2	0.5
5	0.55
10	0.59
20	0.63

Table 15 presents threshold erosional and deposition velocities for sediment grain sizes of 0.4, 0.2, 0.05, and 0.015 mm based on the Hjulström diagram. The 0.2 mm grain size corresponds to the minimum threshold velocity in the diagram. As can be seen, the threshold velocities for 0.2 mm compare with the velocities calculated for the minimum sand size using Equation (4).

Table 15
Critical Velocities for Erosion and Deposition[a]

Grain Size (mm)	Erosional Threshold Velocity (ft/sec)		Deposition Velocity (ft/sec)
	High	Low	
0.4	0.68	0.57	0.10
0.2	0.66	0.56	0.05
0.05	0.98	0.72	0.01
0.015	1.7	1.5	0.003

[a] Based on the Hjulström Diagram

Erosion/Deposition Potential

Areas that are prone to deposition or erosion can be identified based on the values presented in Tables 14 and 15. For the purposes of this study, the potential for erosion is considered high in areas with average velocities greater than 1.5 ft/sec and moderate in areas with average velocities greater than 0.6 ft/sec corresponding to the approximate threshold velocities required to mobilize silt and fine sand particles, respectively. Areas prone to deposition are considered to be those with maximum velocities less than 0.1 ft/sec corresponding to the velocity at which medium sand will settle out. Figures 11 through 15 indicate areas in the tidal saltmarsh that are prone to deposition or erosion based on this criteria, along with the results of the model runs. Figures 11 through 13 illustrate the current conditions in the tidal saltmarsh, while Figures 14 and 15 indicate the conditions prior to construction of the POLB ponds.

Under present conditions, the main channels for all three of the arms of the tidal saltmarsh generate sufficient velocities over most of their lengths to mobilize bottom sediments. Areas that are prone to deposition are generally at the ends of the smaller tributary channels and in the POLB ponds.

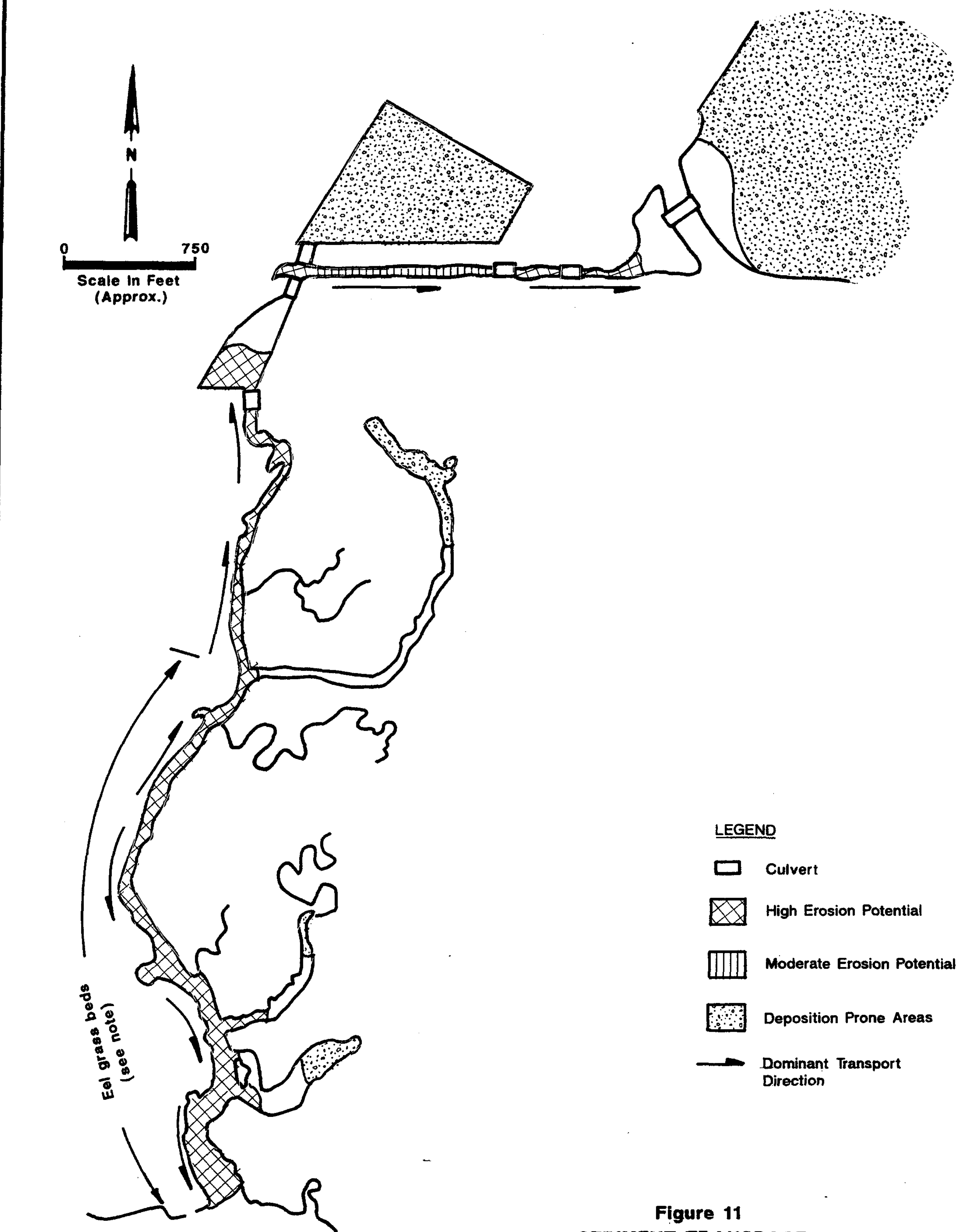
Models of the pre-POLB pond conditions for the west and east arms show much less tendency for erosion than under present conditions. The west arm model results indicate that sufficient velocities could have been developed over the lower two thirds of the arm to mobilize sand-sized particles, with deposition potential at the end of the main channel and ends of the minor branch channels. The east arm results indicate that without the POLB ponds, there was little to no tendency for erosion through the main channel. Again, areas at the ends of the main and branch channels are prone to deposition.

Threshold velocities determined above for sediment mobilization assume that the bottom sediments are exposed directly to the currents. Field observations indicate that this was not the case for areas of the tidal saltmarsh that are occupied by eel grass. Coverage of eel grass varied from patches to complete coverage from shore to shore in some tidal channels. Where present, eel grass shelters the bottom sediments from the currents and reduces the potential for sediment movement. Eel grass is generally more prevalent in the lower portions (bayward) of the arms.

Although eel grass will reduce the amount of sediment mobilization, patches of exposed sediments appear to be present in most sections of the tidal saltmarsh. As a result, the potential for sediment mobilization remains in most areas as shown in Figures 11 through 13.

Conclusions

The construction of the POLB ponds in 1990 has increased the amount of water pulled into the NWR tidal saltmarsh during each tidal cycle (tidal prism) and has increased flow



NOTE: Scattered eel grass beds were noted during field studies in the areas indicated.

Figure 11
SEDIMENT TRANSPORT POTENTIAL IN THE WEST ARM OF THE SEAL BEACH NWR

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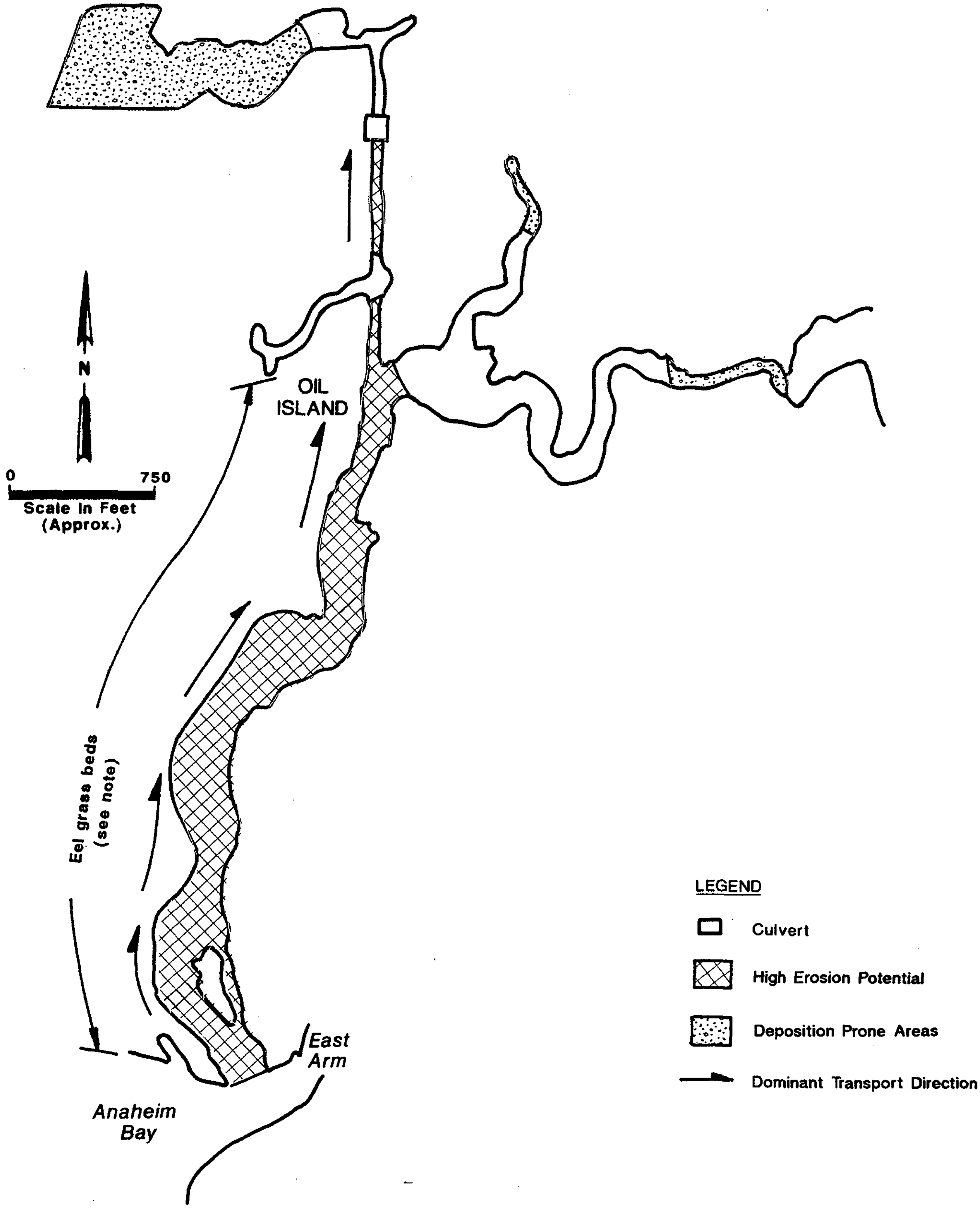

Figure 12
SEDIMENT TRANSPORT POTENTIAL IN THE MIDDLE ARM OF THE SEAL BEACH NWR

NOTE: Scattered eel grass beds were noted during field studies in the areas indicated.

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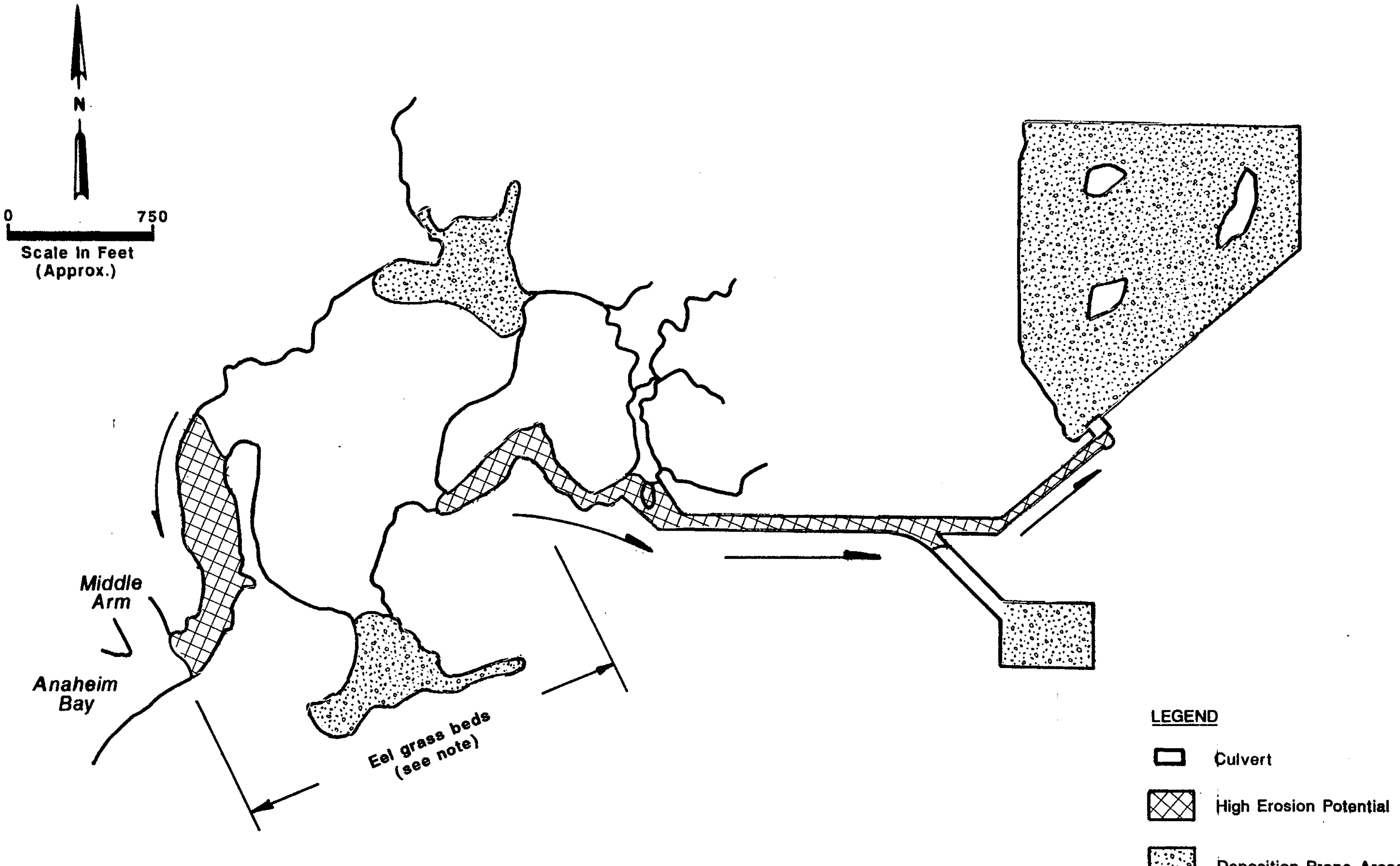

NOTE: Scattered eel grass beds were noted during field studies in the areas indicated.

Figure 13
SEDIMENT TRANSPORT POTENTIAL IN THE EAST ARM OF THE SEAL BEACH NWR

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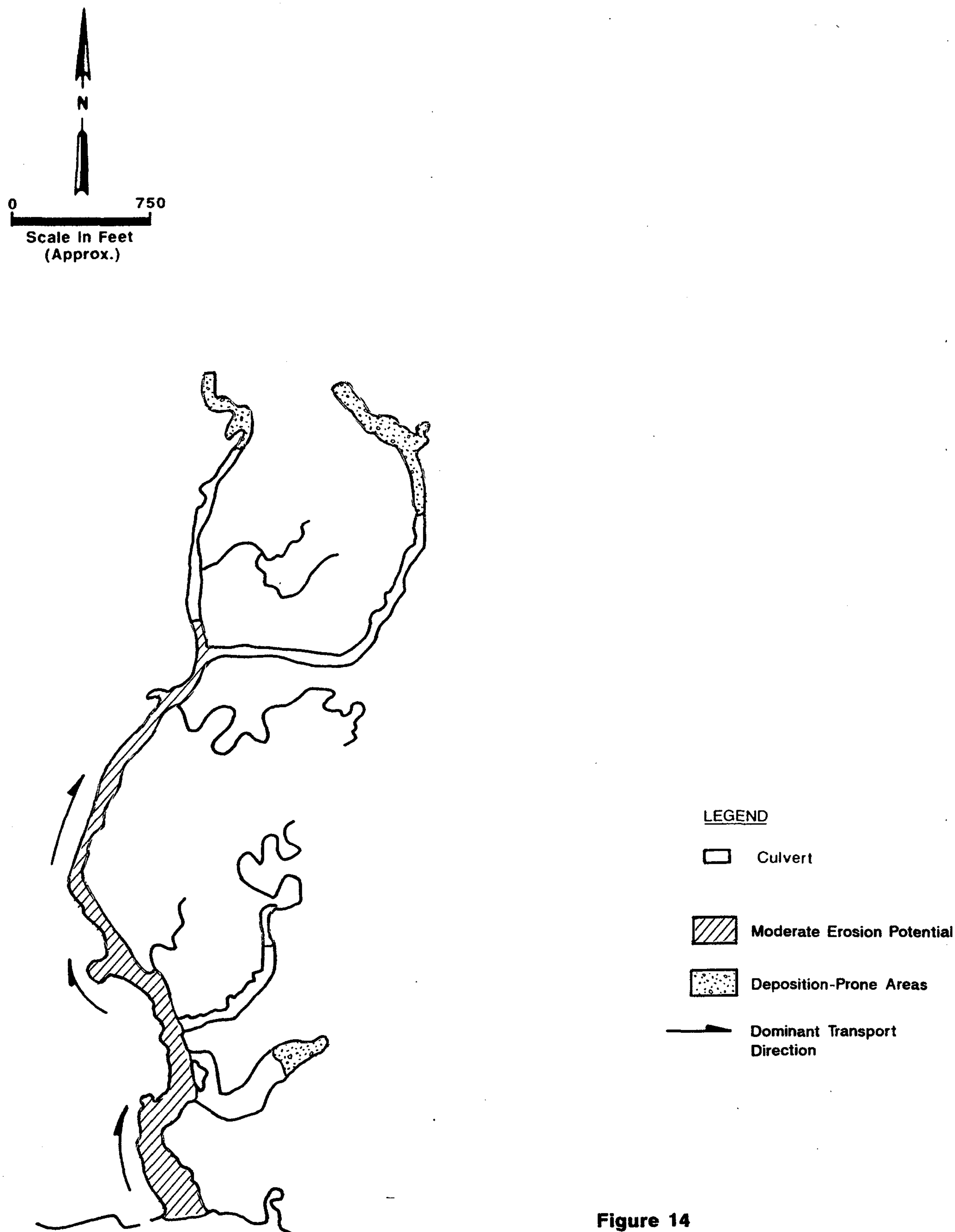

Figure 14
SEDIMENT TRANSPORT POTENTIAL IN THE WEST ARM OF THE SEAL BEACH NWR - PRE-POLB POND CONDITIONS

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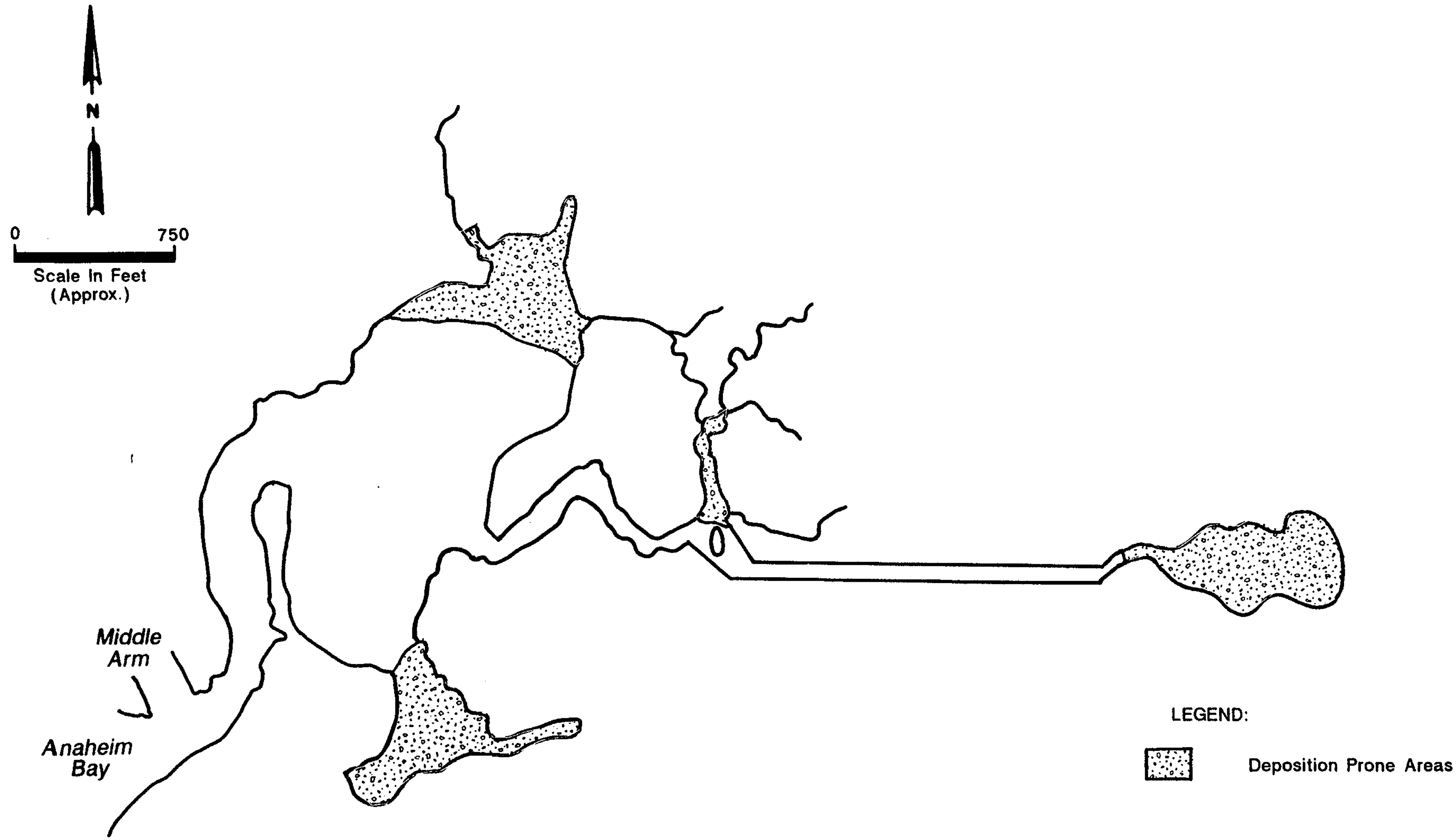

Figure 15
SEDIMENT TRANSPORT POTENTIAL IN THE EAST ARM OF THE SEAL BEACH NWR-PRE-POLB CONDITIONS

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velocities in the tidal channels. This has resulted in significant changes in patterns of sediment erosion and deposition in the NWR, which can affect the distribution of contaminants. Some areas that were not prone to erosion prior to the construction of the POLB ponds are now expected to experience erosion. For example, prior to the POLB pond construction, there was moderate potential for erosion in the lower two thirds of the western arm of the tidal saltmarsh. After POLB pond construction, velocities in the channel increased to the point that the entire length of the western arm below Bolsa Avenue has high erosion potential. The result is that contamination in areas that are subject to increased erosion (for example, the western arm of the NWR) could be reduced, while areas of deposition (for example, the POLB ponds) could experience increased contamination.

The time required for the redistribution of sediments from the pre-POLB pond to post-POLB pond conditions depends on the characteristics of sediments in the affected areas and coverage of the tidal channels by eel grass (which reduces erosion, but is, itself, susceptible to scouring by increased tidal velocities). It is possible that when samples for the NWR study were taken in 1992, 2 years following the construction of the POLB ponds, sediment distribution was (and still may be) in flux.

The increased tidal prism resulting from the construction of the POLB ponds also results in increased intrusion of water from Anaheim Bay into the NWR tidal saltmarsh system. This will result in significantly more water from Anaheim Bay flowing into the NWR during tidal exchange. Tidal exchange with Anaheim Bay is one potential source of contaminants into the NWR tidal saltmarsh system because runoff from virtually the entire urban watershed surrounding the NWR enters Anaheim Bay directly or from Bolsa Chica Channel and Huntington Harbour. STORET DATA included in Appendix A, Watershed Characterization, indicate the potential for addition of contaminants to the NWR from this increased flow from Anaheim Bay. Additionally, stratification of the contaminated freshwater from the Bolsa Chica Channel over the saline water of the bay would reduce mixing and dilution of this contaminated water with relatively clean water from Anaheim Bay. This would result in increased concentrations of contaminants entering the NWR.

Runoff from the NWS to the northwest of the NWR discharges into the western arm of the tidal saltmarsh near the intersection of Kitts Highway and Bolsa Avenue. Agricultural runoff from the NWS discharges into the Bolsa Cell of the NWR in an area that is connected hydraulically to the central arm of the NWR. The elevated contaminant concentrations identified in sediments and biota (see Appendix C, Evaluation of Seal Beach NWR Sediment Chemistry Data, and Appendix D, Environmental Contaminants in the Food Chain, NWS Seal Beach) indicate possible contribution of contaminants from the NWS.

Subsidence ongoing in the Seal Beach area is expected to result in increased sedimentation in the NWR, particularly over the tidal flats. Subsidence of the tidal saltmarsh will result in greater inundation with water from Anaheim Bay (greater depth for longer periods of time) resulting in more sediments deposited onto the tidal flats. This increases the potential for contaminated sediments suspended in water from Anaheim Bay to be deposited in the NWR.

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REFERENCES

Bhogal, V.K. March 1989. "A Sediment Dynamics Model for Flood and Tidal Delta Evolution." *Marine Technology Society Journal.* 23(1):37-43.

Bhogal, V.K., and S.L. Costa. 1989. Modeling Flood Tidal Deposits in Tidal Inlets. *Oceans 89*.

CH2M HILL. September 11, 1989. *Changes in Salinity in Coyote Creek because of Municipal Effluent Flow, Stream Flow, and Bathymetry. Draft Technical Memorandum.*

Costa, S.L., and J.D. Isaacs. November 1977. The *Modification of Sand Transport in Tidal Inlets*. Proc. Symposium on Coastal Sediments and Structures, ASCE. Charleston, South Carolina.

Graff, W. H. 1971. *Hydraulics of Sediment Transport*. McGraw-Hill, Inc.

National Ocean Service. 1993. Tide Tables 1993, High and Low Water Predictions, West Coast of North and South America, Including the Hawaiian Islands. U.S. Department of Commerce.

Koutitas, C. G. 1988. *Mathematical Models in Coastal Engineering*. Pentech Press Limited.

SeaDyn, Inc. March 22, 1993. Anaheim Bay Wetlands Tide Monitoring. Technical Memorandum from David Dykstra/Sea Dyn, Inc. to Steve Costa/CH2M HILL.

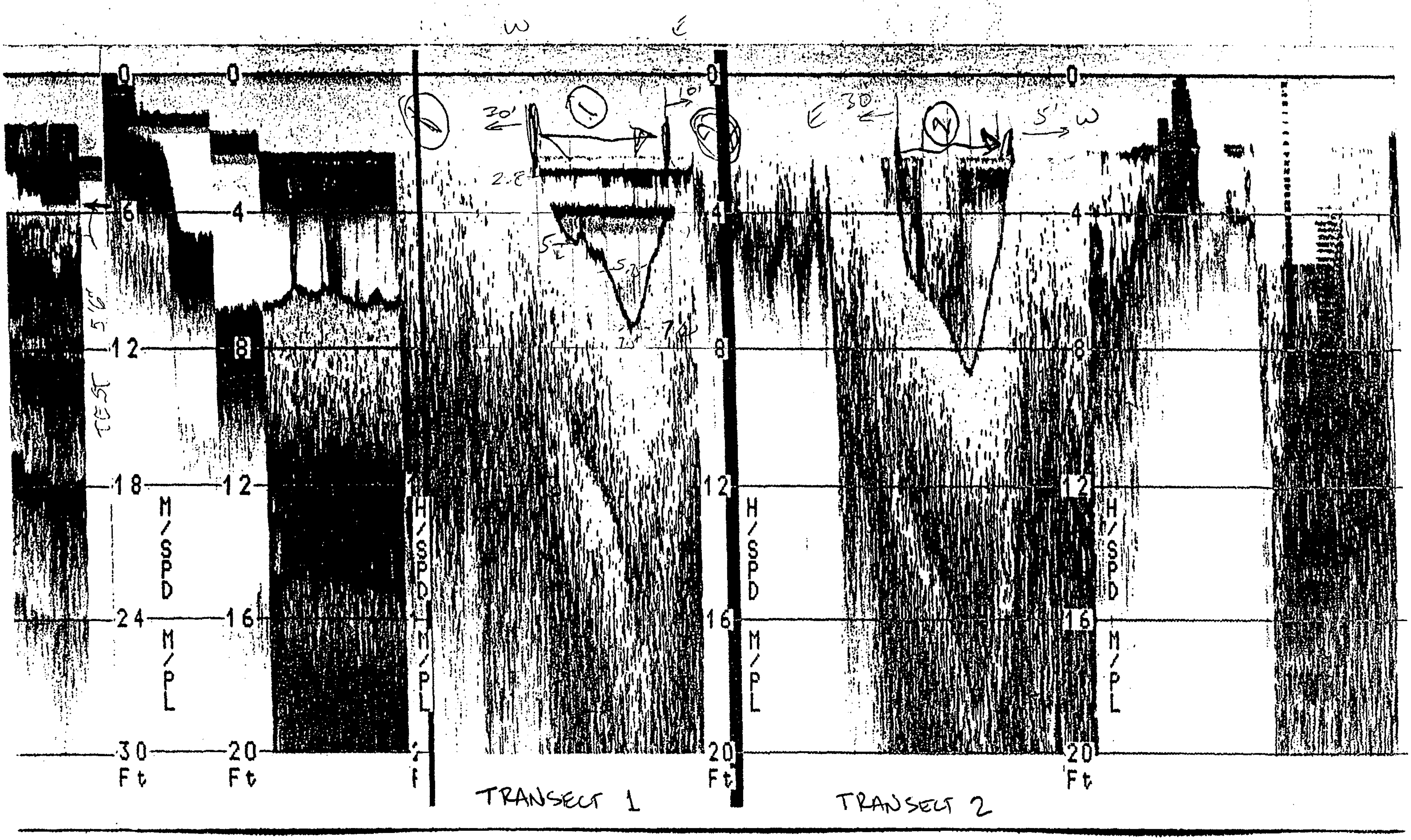
Stauble, D.K., et al. 1988. Inlet Flood Tidal Delta Development Through Sediment Transport Processes, pp 319-347 in: D.G. Aubrey and L. Weishar (eds.), Hydrodynamics and Sediment Dynamics of Tidal Inlets: Lecture Notes on Coastal and Estuarine Studies. Volume 29. Springer-Verlag.

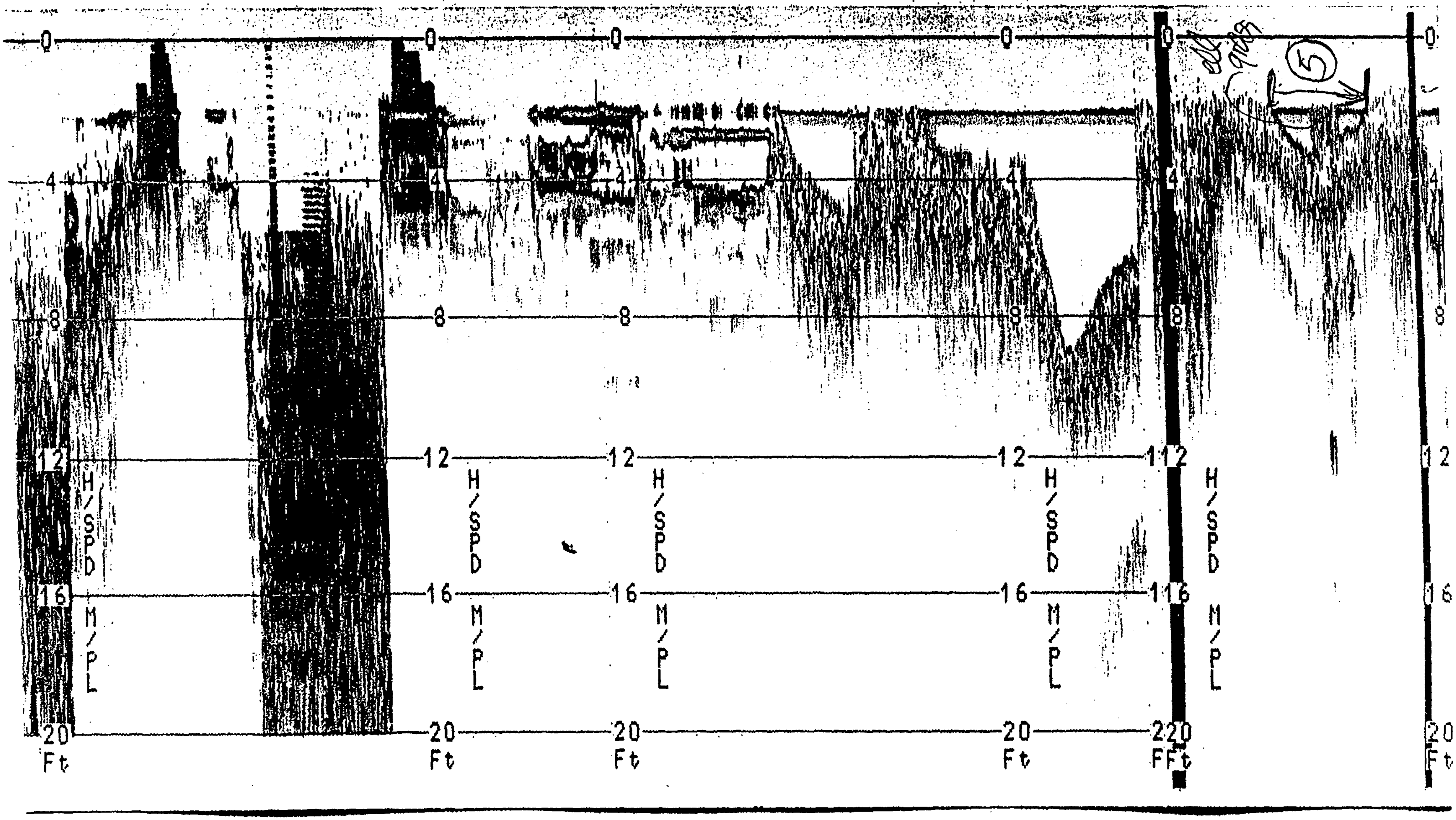
Stauble, D.K., et al. May 1987. *Sediment Dynamics of a Sand Bypass Inlet.* Reprinted from "Coastal Sediments '87." WW Div./ASCE. New Orleans, LA.

Attachment 1

BATHYMETRIC AND WATER COLUMN PROFILE DATA

NOTE: ADD 4" TO ALL READINGS
(= 0.33 ft)





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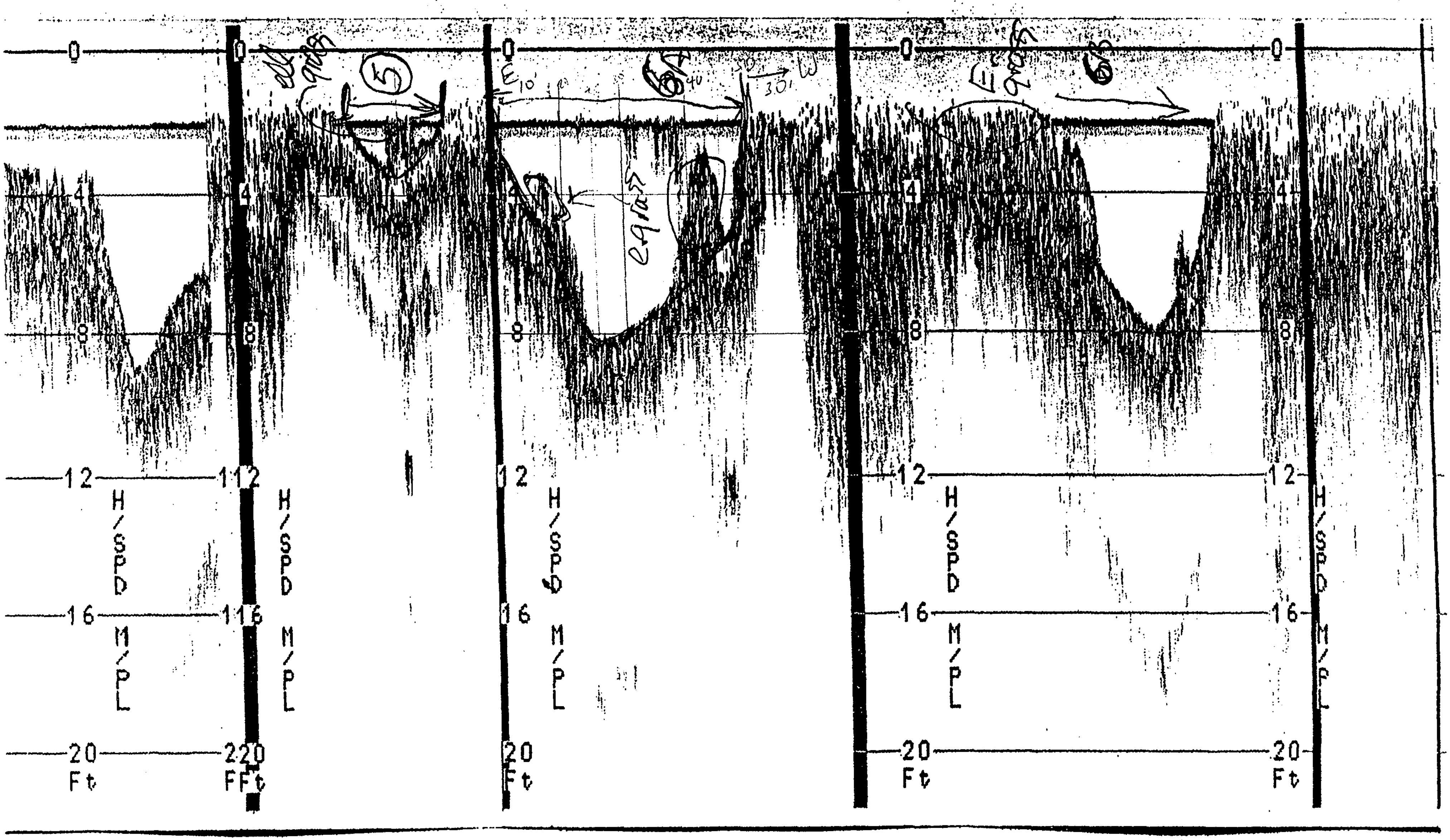
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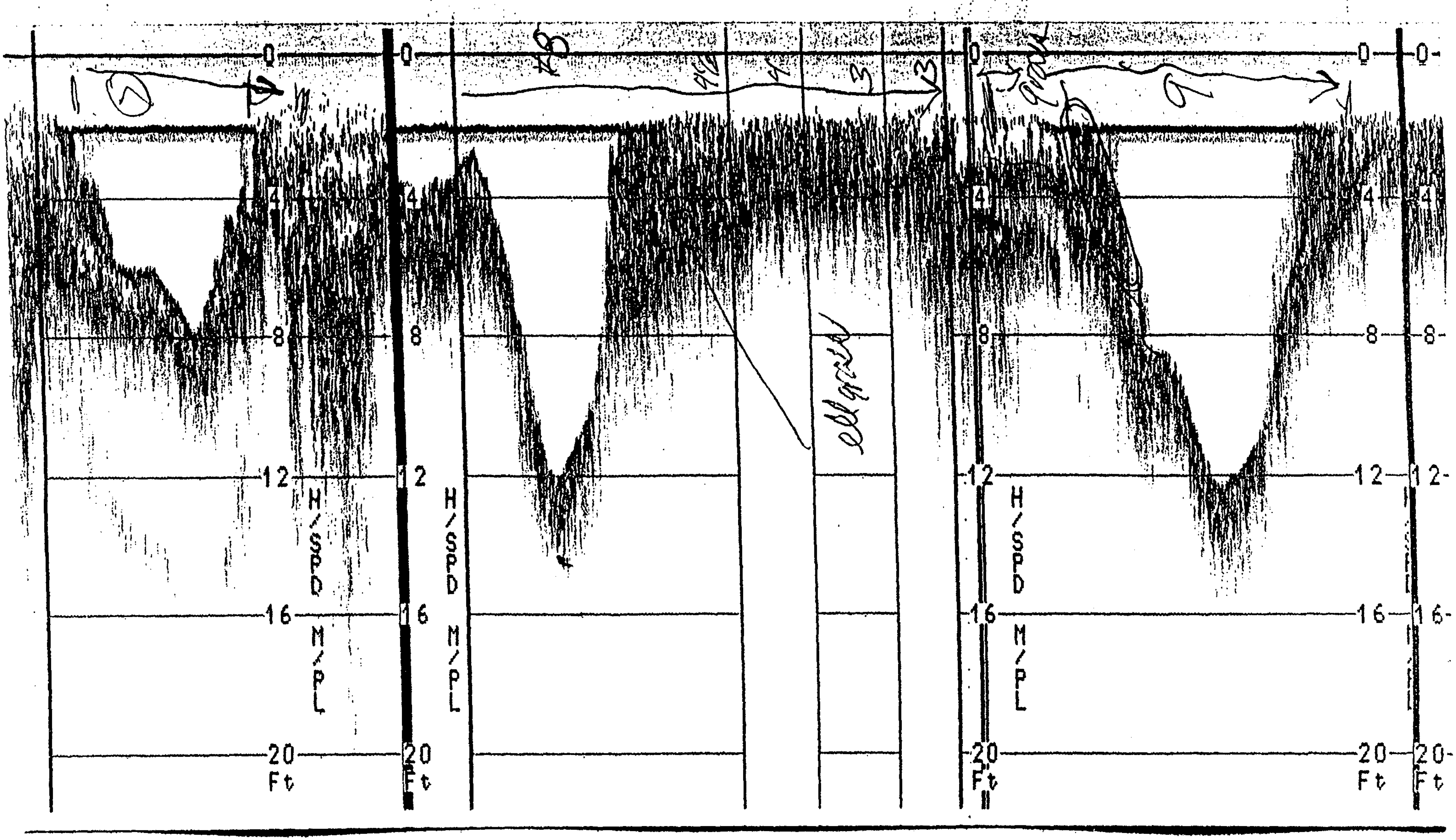
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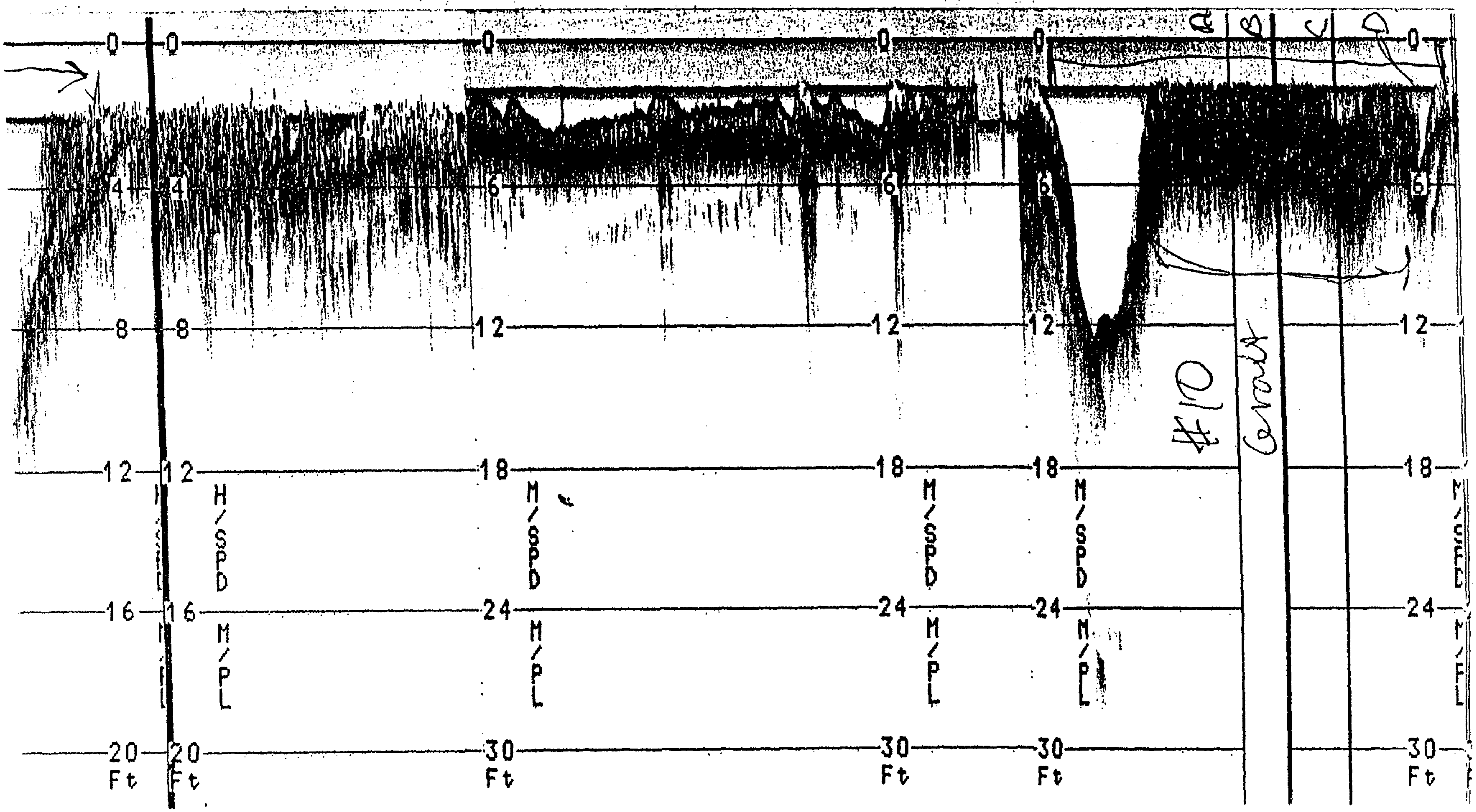
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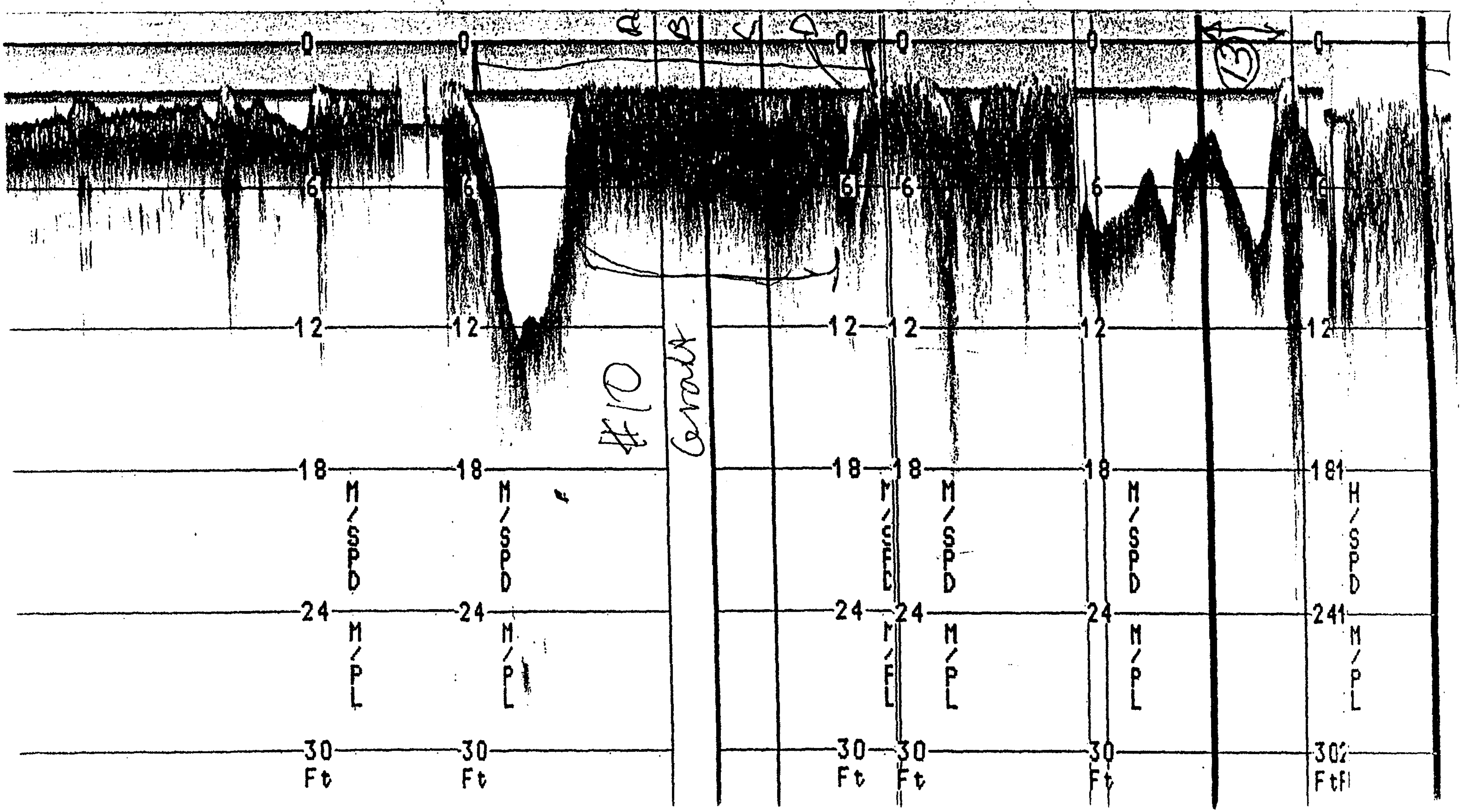
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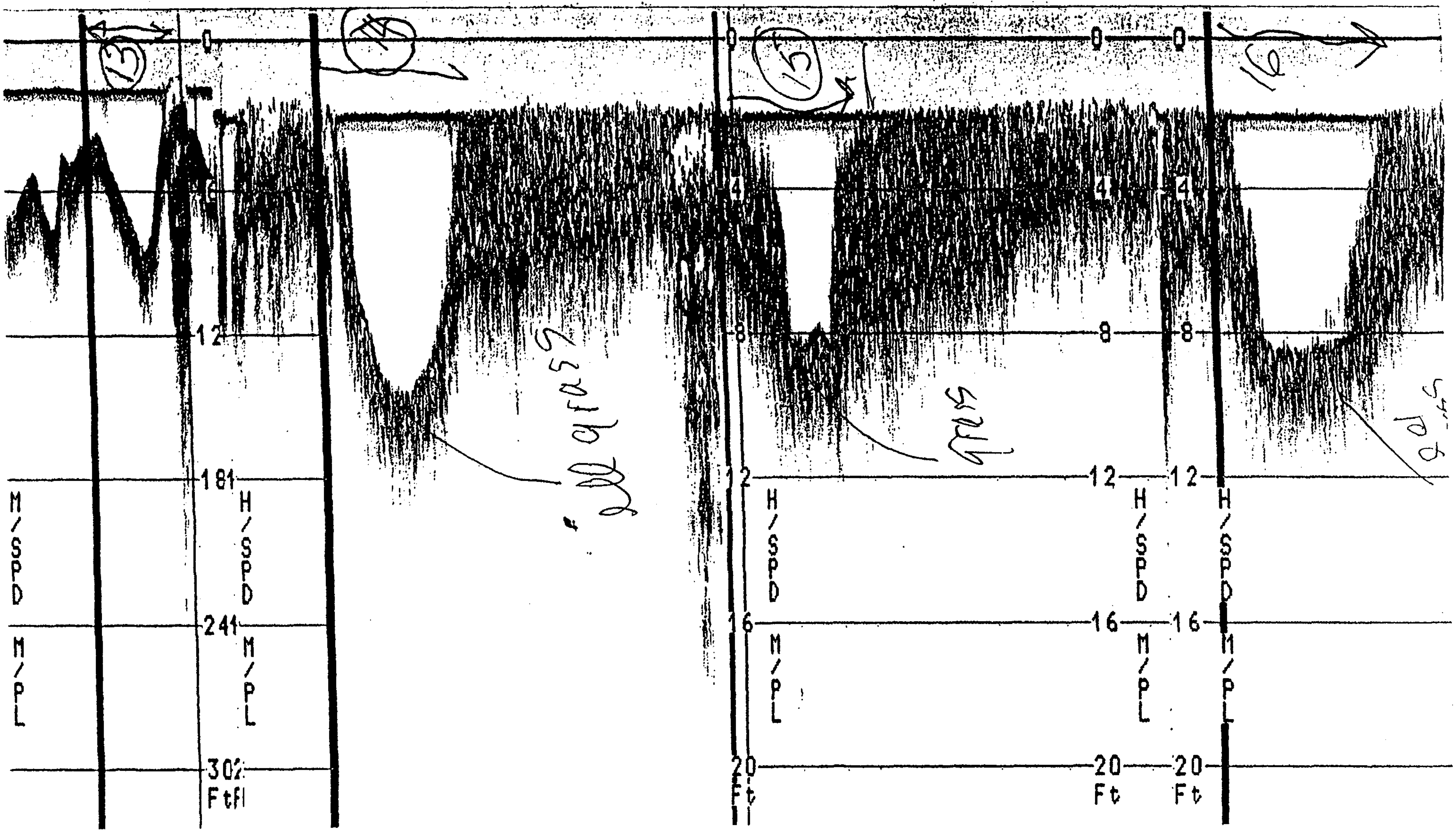
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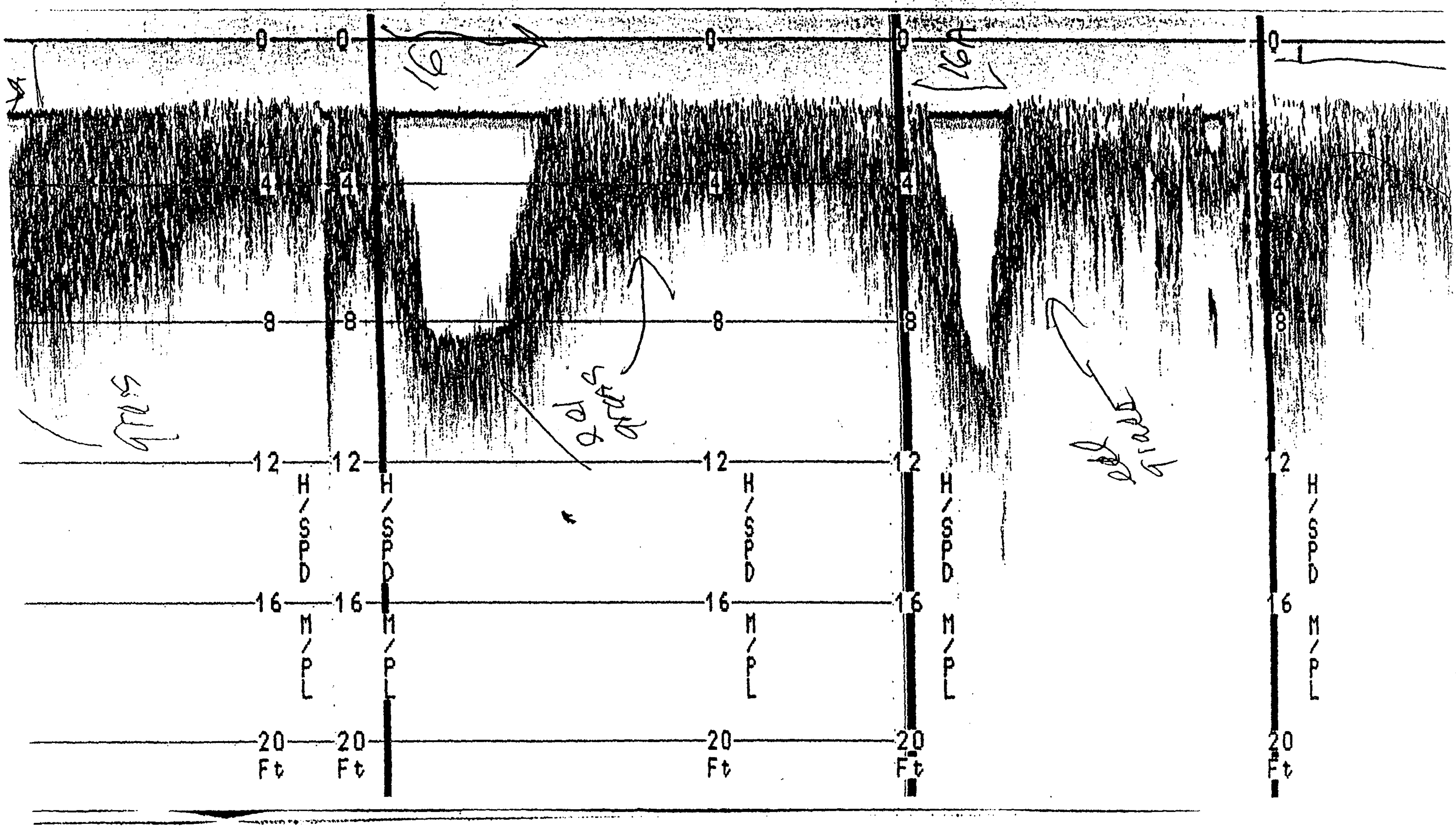
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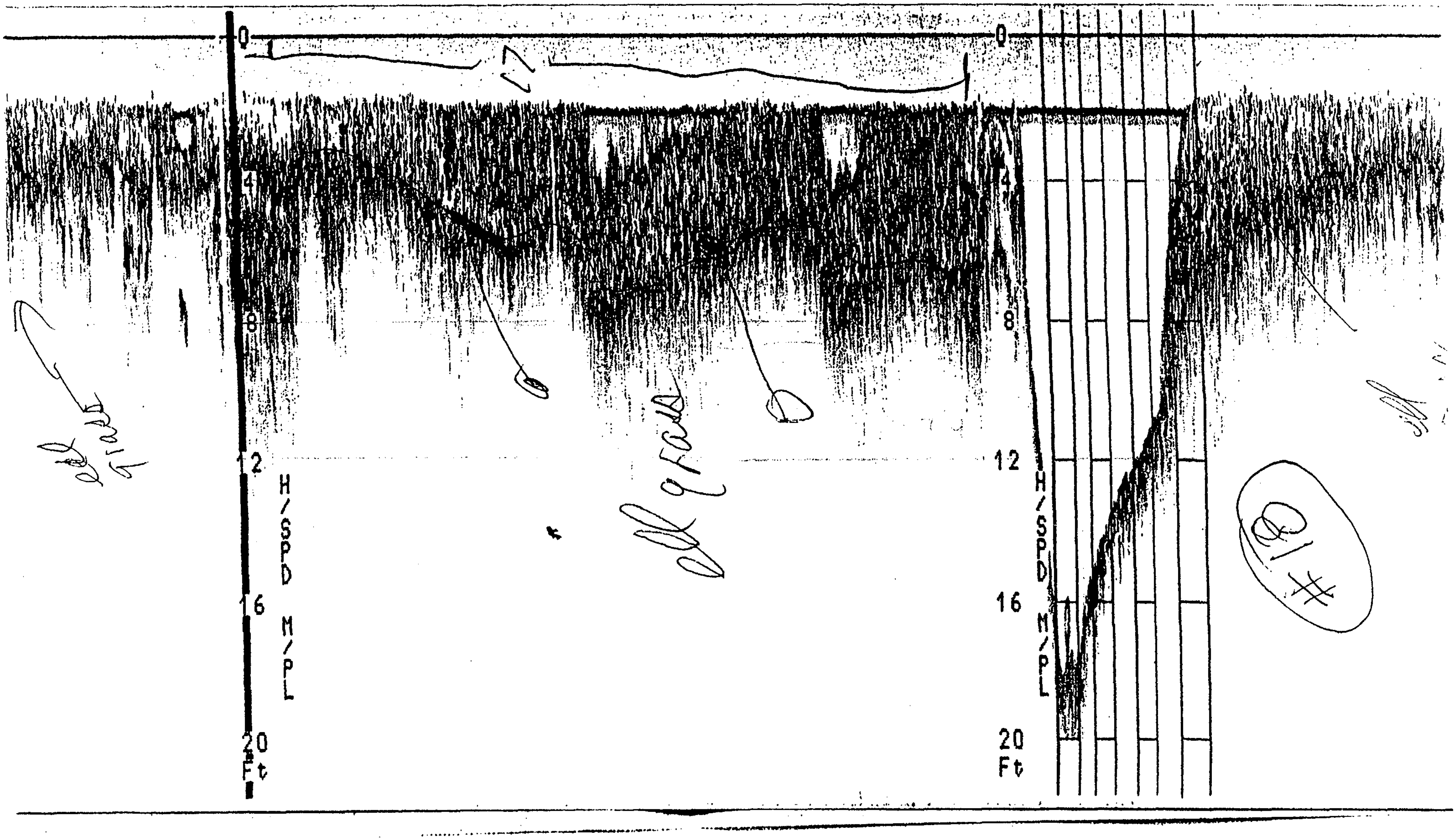
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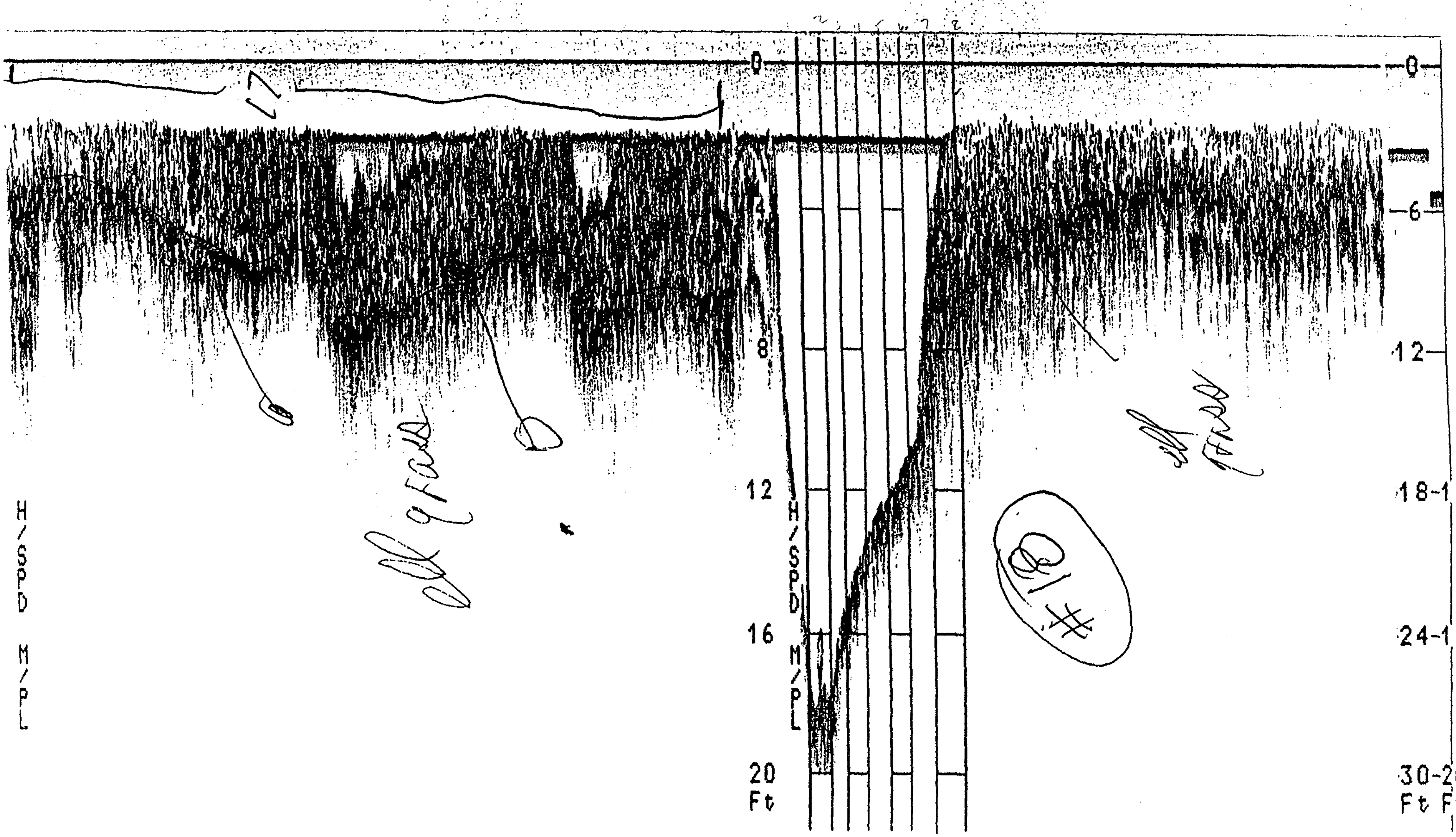
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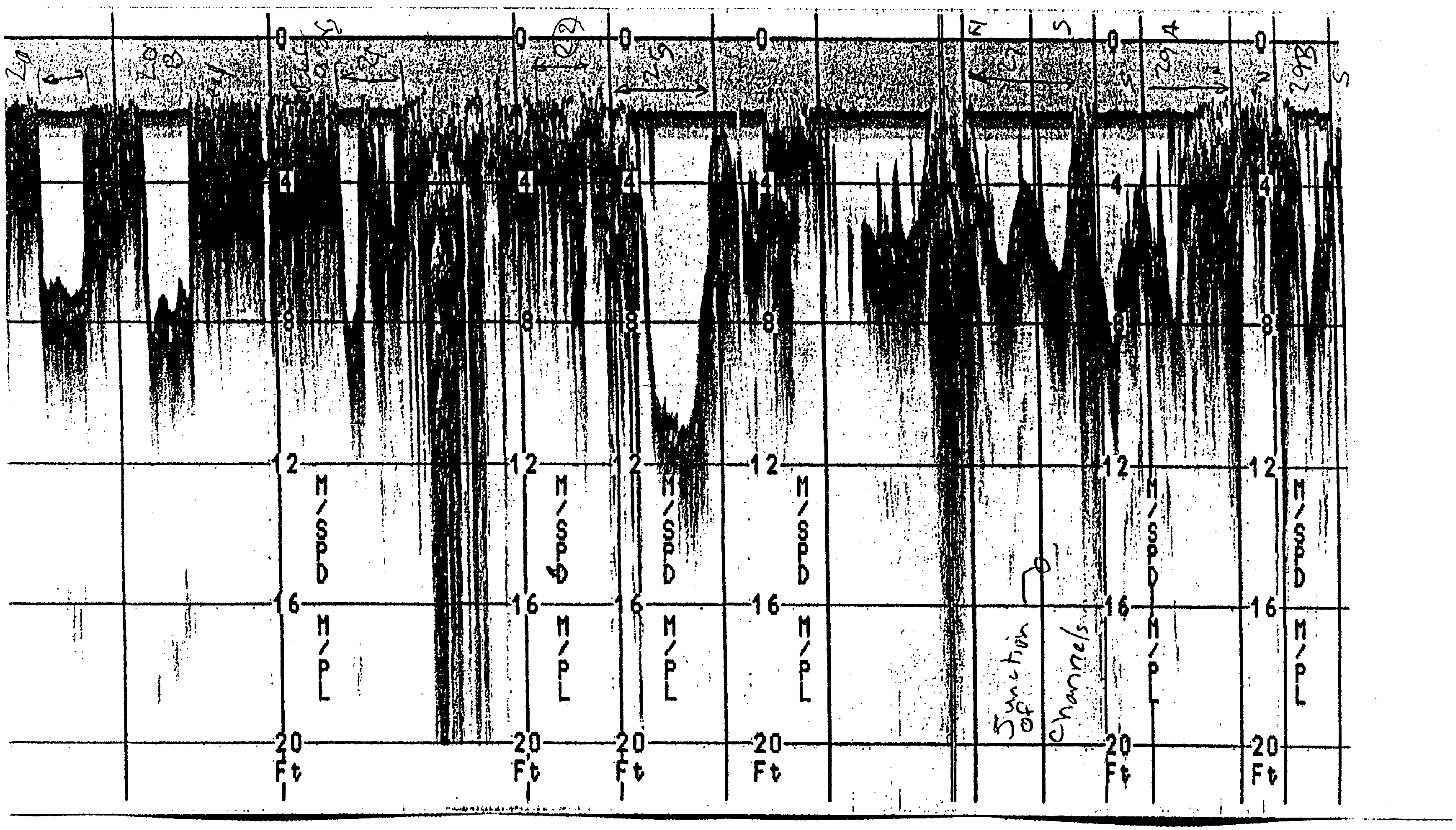
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N
S
29A
29B
Junction of channels

NWS SB-NWR 1 NOV 92 W/W ARM

TRANSECT NO. 1 START 8:20 PST

START W BANK 30 FT FROM SHORE

FINISH E BANK 10 FT FROM SHORE

NOTES:

$T_B = 19.0°C$ $T_S = 19.0°C$

$S_B = 28.5‰$ $S_S = 28.5‰$

NWS SB-NWR 1 NOV 92 W/W ARM

TRANSECT NO. 2 START 8:30 PST

START E BANK 30 FT FROM SHORE

FINISH W BANK 5 FT FROM SHORE

NOTES:

$T_B = 19.5°C$ $T_S = 19.5°C$ @ 8^{45}

$S_B = 32‰$ $S_S = 32‰$

NWS SB-NWR 1 NOV 92 W/E ARM

TRANSECT NO. 3 START 08:57 PST

START — BANK — FT FROM SHORE

FINISH — BANK — FT FROM SHORE

NOTES: Max Depth ≈ 8" – Mud flats (bird tracks) all across channel
T = 18°C
S = 32‰
(NO Depth Trace Done)

NWS SB-NWR 1 NOV 92 W/E ARM

TRANSECT NO. 3A/3B/3C START 9:05 PST

START ______ BANK ______ FT FROM SHORE

FINISH ______ BANK ______ FT FROM SHORE

NOTES: Depth in Center @ 3A ≈ 2ft
@ 3B ≈ 3ft
* NO TRACE TAKEN @ 3C ≈ 3-4ft

* Fairly constant Depth Across the channel

NWS SB-NWR 1 NOV 92 W/E ARM

TRANSECT NO. 4 START 9:12 PST

START — BANK — FT FROM SHORE

FINISH — BANK — FT FROM SHORE

NOTES: 4ft max about 20ft from east bank
2ft about 10 ft from west bank

T_B = 18.5°C T_S = 18.5°C

S_B 32.5‰ S_S = 32.5°C

NWS SB-NWR 1 NOV 92 W/E ARM

TRANSECT NO. 5 START 9:22 PST

START W BANK 20 FT FROM SHORE

FINISH E BANK 15 FT FROM SHORE

NOTES: Ell grass in center of channel, grass beds scattered along this reach

T_B = 19.5°C T_S = 19.5°C

S_B = 32‰ S_S = 32‰

NWS SB-NWR 1 NOV 92 W ARM

TRANSECT NO. 6A START 9:30 PST

START E BANK 10 FT FROM SHORE

FINISH W BANK 30 FT FROM SHORE

NOTES:

NWS SB-NWR 1 NOV 92 W ARM

TRANSECT NO. 6B START 9:34 PST

START W BANK 30 FT FROM SHORE

FINISH E BANK 10 FT FROM SHORE

6A & 6B @ Same location

NOTES:

$T_B = 19.5°C$ $T_S = 19.5°C$

$S_B = 32.25‰$ $S_S = 32.25‰$

NWS SB-NWR 1 NOV 92 W ARM

TRANSECT NO. 7 START 09:45 PST

START W BANK 10 FT FROM SHORE

FINISH E BANK 40 FT FROM SHORE

eel grass beds scattered in channel

NOTES:

$T_B = 19.5°C$ $T_S = 19.5°C$

$S_B = 32.25‰$ $S_S = 32.25‰$

NWS SB-NWR 1 NOV 92 W ARM

TRANSECT NO. 8 START 10:00 PST

START S BANK 6' FT FROM SHORE

FINISH N BANK 60 FT FROM SHORE

Eel grass along N bank

NOTES: Spot soundings at 60, 40, 20, 10 Ft @ 4½, 4, 3, 3 ft respectively

NWS SB-NWR 1 NOV 92 W ARM

TRANSECT NO. 9 START ______ PST

START N BANK * FT FROM SHORE

FINISH S BANK 3D FT FROM SHORE

* @ ≈ 3½ ft from bank to 30 ft

NOTES: can see on trace

NWS SB-NWR 1 NOV 92 W/B2 ARM

TRANSECT NO. SPOT 9A,B,C START 10:15 PST

START — BANK — FT FROM SHORE

FINISH — BANK — FT FROM SHORE

NOTES: Along Center A ≈ 4-4½'

B ≈ 5'

C ≈ 3'-3½'

NWS SB-NWR 1 NOV 92 W/B-2 ARM

TRANSECT NO. Spot 9 D START 10:25 PST

START — BANK — FT FROM SHORE

FINISH — BANK — FT FROM SHORE

NOTES: Spot ≈ 4 ft

NWS SB-NWR 1 NOV 92 W ARM

TRANSECT NO. 10 START 10:30 PST

START S BANK 10 FT FROM SHORE

FINISH N BANK — FT FROM SHORE

NOTES: e.grass started @ ≈ 40% across
depth at A, B, C on chart 6-7'
D on chart no grass

$T_B = 20°C$ $S_B = 32.25‰$ $T_S = 20°C$ $S_S = 31.5$ *

* Salinity change @ ≈ 4 1/2 ft below surface

NWS SB-NWR 1 NOV 92 C/W ARM

TRANSECT NO. 11 START 11:05 PST

START E BANK ____ FT FROM SHORE

FINISH W BANK ____ FT FROM SHORE

NOTES: Pole soundings @ distances across channel

1/4 = 4½'
1/2 = 6¼'
3/4 = 4½'

T_B = 20¼°C
S_B = ~~[illegible]~~ ‰
T_S = 20¼°C
S_S ~~[illegible]~~ ‰

S_B = 31.75
= 31.75‰

NWS SB-NWR 1 NOV 92 C/C ARM

TRANSECT NO. 12 START 11:15 PST

START E BANK ____ FT FROM SHORE

FINISH W BANK ____ FT FROM SHORE

NOTES: Pole Soundings

1/4 3.75'
1/2 3.75'
3/4 3.0'

T_B = 20.25°C
S_B = 31.75‰
T_S = 20.5°C
S_S = 32‰

NWS SB-NWR 1 NOV 92 C/E ARM

TRANSECT NO. 13 START 11:29 PST

START S BANK 10 FT FROM SHORE

FINISH N BANK 50% FT FROM SHORE

Spot Soundings N-half ≈ 3'

NOTES: $T_B = 20°C$ $T_S = 20.5°C$

$S_B =$ ~~0~~ 31.75 ‰ $S_S =$ ~~3~~ 32 ‰

NWS SB-NWR 1 NOV 92 C ARM

TRANSECT NO. 14 START 11:40 PST

START E BANK 5 FT FROM SHORE

FINISH W BANK 50% FT FROM SHORE

Spot soundings 50% - 5'

NOTES: 75% 4'

90% 3'

NWS SB-NWR 1 NOV 92 C ARM

TRANSECT NO. 15 START 11:48 PST

START W BANK 10 FT FROM SHORE

FINISH E BANK 60% FT FROM SHORE

NOTES: Spots of 50%, 75% 85% were 6.5, 5, & 4 ft

T_B = 20.5°C | T_S = 20.75°C

S_B = 31 ‰ S_S = ~~3~~ 31.25 ‰

NWS SB-NWR 1 NOV 92 ____ ARM

TRANSECT NO. 16 START 12:00 PST

START W BANK 20 FT FROM SHORE

FINISH E BANK 50% FT FROM SHORE

NOTES: Spot depths at 60% 75% 85% of 4', 3½' 3'

NWS SB-NWR 1 NOV 92 C ARM

TRANSECT NO. 16A START 12:08 PST

START W BANK 20 FT FROM SHORE

FINISH E BANK 60% FT FROM SHORE

NOTES: Spot @ 50, 75, 5' and 3 1/2'

NWS SB-NWR 1 NOV 92 C ARM

TRANSECT NO. 17 START 12:15 PST

START E BANK — FT FROM SHORE

FINISH W BANK — FT FROM SHORE

NOTES: Spot depts

eel grass puts bottom 1-3 ft higher than actual reading on fathometer

Dist	Dept
30'	3'
25%	3 1/2'
50%	5 3/4
75%	6'
-30'	6'

NWS SB-NWR 1 NOV 92 C&E ARM

TRANSECT NO. 18 START 12:25 PST

START E BANK 10 FT FROM SHORE

FINISH W BANK B#8 see Buoys FT FROM SHORE

NOTES: Buoy 18 - 3ft
Buoy 15 - 5ft
Buoy 19 - 3ft
Spot readings
$T_B = 21$ $T_S = 21.5$
$S_B = 31$ $S_S = 30.25$

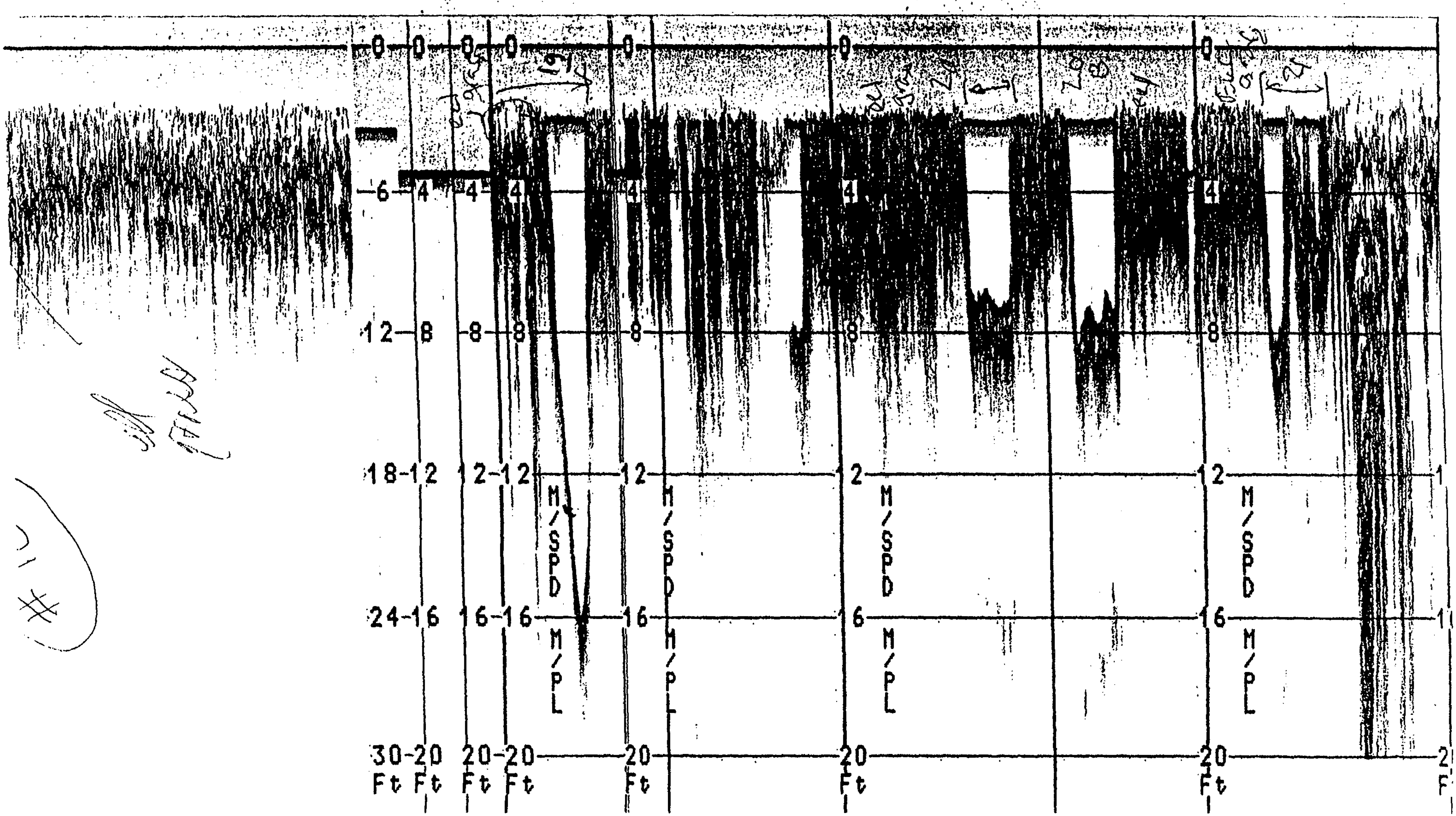
NWS SB-NWR 1 NOV 92 E ARM

TRANSECT NO. 19 START 1:40 PST

START W BANK 1/2 channel FT FROM SHORE

FINISH E BANK 20 FT FROM SHORE

NOTES: Spot readings
2½' ~50' from W bank
4¼' @ ¼ channel from W. Bank
6½' @ ½ channel


0
6
12
18
24
30 Ft
4
8
12
16
20 Ft
M/SPD
M/PL

NWS SB-NWR 1 NOV 92 E ARM

TRANSECT NO. 20 START 1:55 PST

START W BANK ~~80~~ ~200 ft ! 1/3 channel width FT FROM (E) (point) SHORE

FINISH E (Point) BANK 40 FT FROM SHORE

NOTES: 2 Runs, channel close to east point.
Spot readings 50' from W. Bank 6'
1/3 width from W. Bank 7.75
2/3 width from W. Bank 5.5'

T_B = 20.5 T_S = 21

S_B = 31.0 S_S = 31

NWS SB-NWR 1 NOV 92 E ARM

TRANSECT NO. 21 START 2:15 PST

START Point BANK 30% FT FROM ~~point~~ SHORE

FINISH BANK 40% FT FROM Point SHORE

NOTES: spot readings
3½' ~ 50' from point
7' ~ ¼ channel from point
2' ~ ½ + channel width

Constant depth ~2' from channel to tributary

NWS SB-NWR 1 NOV 92 E ARM

TRANSECT NO. 22 START 2:25 PST

START — BANK — FT FROM SHORE

FINISH — BANK — FT FROM SHORE

SPOT READINGS

NOTES: W

40' shore 3' 3½ 3½ 3½ 2 Island

30'

Spot Readings 22a - 2½'
22b - 2½' (back side of island

NWS SB-NWR 1 NOV 92 E ARM

TRANSECT NO. 23 START 2:35 PST

START ______ BANK ______ FT FROM SHORE

FINISH ______ BANK ______ FT FROM SHORE

Spot W → E

NOTES: 50' ¼ ½ ¾

3½' 3½ 3½ 3

$T_B = 20\frac{1}{2}$ °C $T_s = 21.25$

$S_B = 31.5$ ‰ $S_s = 30.75$

NWS SB-NWR 1 NOV 92 E ARM

TRANSECT NO. 24 START 2:50 PST

START ______ BANK ______ FT FROM SHORE

FINISH ______ BANK ______ FT FROM SHORE

(shallow w/ lots of eel grass - fathometer not used

NOTES: Spot Checks

W	50'	1/4	1/2	3/4	50'	E
	5.75'	5.5'	5.5'	3.75'	3'	

NWS SB-NWR 1 NOV 92 E ARM

TRANSECT NO. 25 START 3:00 PST

START S BANK 1/2 way FT FROM South SHORE

FINISH N BANK 5' FT FROM SHORE

NOTES: Spot checks 3' @ 1/4 Dist from South Bank

T_B = 20.75 T_S = 21

S_B = 31.5 S_S = 31.75

Motor cut out as channel edge was reached

(channel appears wider than non-~~[illegible]~~ reading portion of trace)

NWS SB-NWR 1 NOV 92 E ARM

TRANSECT NO. 26 START 3:12 PST

START ______ BANK ______ FT FROM SHORE

FINISH ______ BANK ______ FT FROM SHORE

NOTES: A - 8' on Fathometer digital readout (spot checks)
B - 7 " " " "

NWS SB-NWR 1 NOV 92 ______ ARM

TRANSECT NO. 27 START 3:20 PST

START N BANK 5 FT FROM SHORE

FINISH S BANK 5 FT FROM SHORE

NOTES: IN Dredged channel at junction of channels from POWB pond and

$T_B = 20.5$ $T_S = 21$

$S_B = 32$ $S_S = 32$

NWS SB-NWR 1 NOV 92 E ARM

TRANSECT NO. 28 START 2:35 PST

START ____ BANK ____ FT FROM SHORE

FINISH ____ BANK ____ FT FROM SHORE

NOTES: A - 4½'
B E-4½' MID - 6½' W - 6'

B $T_B = 21°C$ $T_s = 21°C$
$S_B = 32‰$ $S_s = 32‰$

NWS SB-NWR 1 NOV 92 E ARM

TRANSECT NO. 29 START 3:45 PST

START S BANK 7' FT FROM SHORE

FINISH N BANK ____ FT FROM SHORE

NOTES: A - from S to N
B - from N to S. Channel starts @ mid width

Spt check 3' @ 20' from N edge

4:00 In main body of E channel - depths to less than 2 feet - paddled out.

Transect No.	Estimated Arm Width (ft)	Estimated Channel Width (ft)	Est. Depth Outside Channel	Max. Channel Depth	Time of Data	Estimated Tide (MLLW)	Depth Outside Channel (MLLW)	Channel Depth (MLLW)	X-sect. Area (ft^2) MLLW	X-sect. Area (ft^2) MHHW
1	80	40	2.8	7.5	08:20	3.30	0.00	4.20	83.9	483.5
2	80	45	2.5	8.75	08:30	3.31	0.00	5.44	122.3	497.3
3	60	0	0.67	0.67	08:57	3.36	0.00	0.00	0.0	168.6
3a	50	0	2	2	09:05	3.38	0.00	0.00	0.0	206.1
3b	55	0	3	3	09:05	3.38	0.00	0.00	0.0	281.7
3c	80	0	3.5	3.5	09:05	3.38	0.12	0.12	9.7	449.7
4	55	20	2	4	09:12	3.40	0.00	0.60	6.0	231.6
5	55	20	2	3.5	09:22	3.43	0.00	0.07	0.7	224.7
6	80	40	2	8	09:30	3.46	0.00	4.54	90.9	414.5
7	125	75	2	8	09:45	3.51	0.00	4.49	168.3	667.0
8	110	44	3.75	12	10:00	3.57	0.18	8.43	201.0	806.0
9	110	50	3.5	12.25	10:10	3.62	0.00	8.63	215.8	808.0
9a	95	0	4	4.5	10:15	3.64	0.36	0.86	34.3	556.8
9b	95	0	5	5	10:15	3.64	1.36	1.36	129.3	651.8
9c	60	0	3	3.5	10:15	3.64	0.00	0.00	0.0	291.7
9d	125	0	4	4	10:25	3.69	0.31	0.31	39.3	726.8
10	250	90	7	12	10:30	3.71	3.29	8.29	1047.8	2422.8
11	75	40	4.5	6.5	11:05	3.88	0.62	2.62	86.7	499.2
12	110	85	3	3.75	11:15	3.92	0.00	0.00	0.0	503.4
13	200	90	2	8	11:28	3.98	0.00	4.02	180.7	884.0
14	170	80	4	10	11:40	4.04	0.00	5.96	238.6	1167.4
15	250	140	4.5	8	11:48	4.07	0.43	3.93	352.7	1727.7
16	310	135	3.5	8.5	12:00	4.12	0.00	4.38	295.9	1810.0
16a	310	122	4	9.5	12:08	4.14	0.00	5.36	326.7	1986.7
17	280	280	3.5	7.25	12:15	4.17	0.00	3.08	431.4	1784.2
18	450	150	4	18	12:25	4.20	0.00	13.80	1035.0	3420.3
19	265	112	4	16	13:40	4.30	0.00	11.70	655.3	2034.0
20	280	50	6	8	13:55	4.28	1.72	3.72	531.8	2071.8
21	845	84	2	8	14:15	4.23	0.00	3.77	158.4	2923.7
22	190	190	3.25	3.5	14:25	4.19	0.00	0.00	0.0	866.3
23	375	375	3.25	3.5	14:35	4.15	0.00	0.00	0.0	1726.7
24	900	900	4	5.75	14:50	4.07	0.00	1.68	758.2	5649.7
25	110	50	3	11	15:00	4.00	0.00	7.00	174.9	669.6
26a	75	75	8	8	15:12	3.92	4.08	4.08	306.0	718.5
26b	65	65	7	7	15:12	3.92	3.08	3.08	200.2	557.7
27	110	100	4	6.5	15:20	3.86	0.14	2.64	140.5	745.5
28a	45	45	4.5	4.5	15:35	3.74	0.76	0.76	34.4	281.9
28b	31	31	5	6.5	15:35	3.74	1.26	2.76	62.5	233.0
29a	110	55	3	8	15:45	3.65	0.00	4.35	119.7	653.7

Attachment 2

PROGRAM LISTING

```
 ============================================================
'                            PROGRAM "SB-CIRC.BAS"
'                            Version  October 1992
'
'             **** 1DH MODIFIED ONE-LAYER CIRCULATION MODEL ****
'               Modification of BTCHT.BAS, Version 23 May 1990
'                for the Seal Beach National Wildlife Refuge
'
'                  Based on alogrithms from Koutitas (1988)
'
'                   CH2M HILL - Applied Sciences Department
'                           Ocean Technology Group
'This version contains modifications for printout of min,max values
'
'  Summary of Changes:

'        Added ability to input all data from a control file
'        Added capability to run multiple cases
'        Removed salinity calculation
'        Modified channel geometry calculations to allow cases
'        with water levels below MLLW.
''
'============================================================
'

 ESCRIPTION OF INPUT VARIABLES:
'
'  CONTROL FILE:  Contains list of data file names
'                                                (one per line)
'
'
'  DATA FILE:  (one file for each model run)
'
'          IMAGE 1 : Program Control Switches
'-------------------------------------------------------------
'
'          SW1      : switch for printout of title page w/parameter values
'                   = 0 gives no output
'                   = 1 prints out page
'
'          SW2      : switch for line printer output of results
'                   = 0 no line printer output
'                   = 1 lineprinter out put of intermediate and final results
'
'       OUTFILE$    = name of disk file for output

'          SWFI     : switch for input from existing data file
'                   = 0 no input from file (i.e. cold start model run)
'                   = 1 read initial Z,U values from an ASCII file
'
```

```
        FIN$     = name of ASCII file with initial values

'       SWFO     : switch for output to an ASCII file
'                = 0 no output to file
'                = 1 output final results (Z,U) to ASCII file
'                = 2 output intermediate and final results to files
'
'      FOUT$     = name of ASCII file for Z,U results output
'
'       SWT      : switch for type of tidal forcing
'                = 0 for sine wave tides
'                = 1 for synthetic tides
'
'       OPS      : switch for cell data to printout
'                = # (print data for every # cells - starts at 1)
'
'
'       IMAGES 2,3,4
'-----------------------------------------------------------------
'       TITLE{1,2,3}$ are titles printed out on each page of output
'
'
'       IMAGE 5 : Calculation Parameters and Limit Controls
'-----------------------------------------------------------------
'       DT       = time step between iterations in seconds
'       DX       = Ox space step in meters
        IM       = number of grid indices
        EDH      = weighting factor of Lax type time difference
'
'       NM       = maximum number of time steps before program ends
'       NC       = number of time steps between intermediat output
'       TOUT     = interation time when intermediate output begins (hrs)
'       TSTD     = time of steady state (also used for program end or outpu
)
'
'
'       IMAGE 6 : Physical Variables and Parameters
'-----------------------------------------------------------------
'       CF       = bed friction coefficient
'       CS       = surface stress coefficient
'       W        = magnitude of wind speed
'       WPER     = period of wind forcing


'       IMAGE 7 : Tidal and Salinity Parameters
'-----------------------------------------------------------------
'       AMPL     = amplitude of sine tide (m, if used)
'       MSL      = elevation of MSL above MLLW (m)
'       PER      = period of tides (in hours)
'       MHHW     = magnitude of highest high tide (in ft, converted to m)
'       MLLW     = magnitude of lowest low tide   (in ft, converted to m)
```

```
MLHW     = magnitude of lowest high tide  (in ft, converted to m)
MHLW     = magnitude of highest low tide  (in ft, converted to m)

NIQ      = number of grid points where fresh water inflows


IMAGE 8.1, 8.2,....,8.NIQ  : Freshwater Inflow Parameters
-------------------------------------------------------------
(I,0)          = grid indices of main and secondary
                 channel intersections where I = CH(LJ)
CH(J),CHE(J)   = grid indices of cells where freshwater
                 flows are introduced
N(J)           = number of cells in subsidiary channels
FRESH(I,K)     = rates of freshwater inflows (in MGD)
TFLD(I,K)      = times of beginning of discharges (hrs)
DUR(I,K)       = durations of discharge (hrs)
-------------------------------------------------------------
IMAGE 9: Width of Cells IM = 0 to IM , at MLLW

WHL(I,K)        = width of cells (in meters) at MLLW

-------------------------------------------------------------
IMAGE 10: Width of cells IM = 0 to IM at MHHW

WHH(I,K)       = width of cells (in meters) at MHHW

-------------------------------------------------------------
IMAGE 11: X-sec at Cells IM = 0 to IM , below MLLW

XSECL(I,K)     = x-sec at cell centers (in sq meters)

-------------------------------------------------------------

IMAGE 12: X-sec at cells im = 0 to im, between MHHW & MLLW

XSECH(I,K)     = x-sec between MHHW and MLLW
-------------------------------------------------------------

IMAGE 13: width of all the cells in secondary channels
          starting with cell [ch(j),1] ...... [ch(j),km(j)]
          at MLLW : j = number of secondary channel
WHL(I,K) = width of cell at MLLW
-------------------------------------------------------------

IMAGE 14: width of all the cells in secondary channels
          starting with cell [ch(j),1] ...... [ch(j),km(j)]
          at MHHW
WHH(I,K) = width of cell at MHHW

-------------------------------------------------------------
```

```
IMAGE 15: X-SEC of secondary channel cells ch(j),1..ch(j), km(j)
          at MLLW
XSECL(I,K)   =  x-sec of secondary cells at MLLW
```

```
IMAGE 16: X-SEC of secondary channel cells ch(j),1..ch(j), km(j)
          at MLLW
XSECL(I,K)   =  x-sec of secondary cells at MLLW
```

DEFINITION OF PROGRAM VARIABLES:

ARRAY VARIABLES

```
i,k is cell designator index
--------------------------

U(i,k)      = previously calculated value of velocity
UN(i,k)     = velocity currently being calculated
OZ(i,k)     = previously calculated value of elevation
Z(i,k)      = surface elevation currently being calculated


Q(i,k)      = freshwater discharge volume flow rates
H(i,k)      = water depths referenced to swl datum
WHL(i,k)    = width of cell at low water (0 ft)
WHH(i,k)    = width of cell at high water (for coyote creek
              simulation the high water is at 7 ft)
WH(i,k)     = width at the water surface elevation in a cell
              at time t
XSECZ(i,k) = X-section in a cell at time t

NOTE:

            All variables in one dimensional arrays are used
            locally within subroutines for calculating z, u,
            and s.  these arrays are used for temporary holding
            areas for two dimensional array variables


I,K is cell index indicating freshwater discharge
-----------------------------------------------

IQ(I,K)     = cell indices of freshwater inflow locations
DUR(I,K)    = duration of discharge
FRESH(I,K) = freshwater discharge volume flow rates
TFLD(I,K)   = time of discharge start
```

COUNTERS, SWITCHES, AND FLAGS

```
N         = time step number currently working
```

```
'         T         = current time
'         TT        = time in tidal cycle
'
'         SW1       = switch for printout
'         SWFI      = enable input of previous output file
'         SWFO      = create output ASCII file
'         SWT       = select type of tide
'
'=========================================================================
'
'                   PROGRAM INITIALIZATION
'
'=========================================================================
'
'Dimension arrays
'----------------
DIM U#(60,20),UN#(60,20),Q(60,20)
DIM R(60,20),H(60,20),Z#(60,20),OZ#(60,20),WH(60,20)
DIM IQ(60,20),DUR(60,20),FRESH(60,20),TFLD(60,20)
DIM WHL(60,20),WHH(60,20),XSECL(60,20),XSECH(60,20),XSECZ(60,20)
DIM XU#(60),XUN#(60),XQ(60)
DIM XH(60),XZ#(60),XOZ#(60),XWH(60)
DIM IOUT(20),KOUT(20)
'%%
DIM LOWZ#(60,20),HIGHZ#(60,20),LOWU#(60,20),HIGHU#(60,20)
DIM LOWZT(60,20),HIGHZT(60,20),LOWUT(60,20),HIGHUT(60,20)

'Input data file name and open for input
'---------------------------------------
CLS
input "What is name of control file: "; Controlfile$
open Controlfile$ for input as #7
'open "run.dat" for input as #8         '  run.dat is a record of runs made

                        '  during a session
while not eof(7)
line input #7, datafile$
open datafile$ for input as #1
'
'Set constants, initial loop parameters, and I/O switches
'--------------------------------------------------------
PI  = 3.14159
RAD = 57.2958
'
N=0: T=0: TT=0.0
'
input#1,SW1,SW2                  'switches for printout
input#1, outfile1$               'output file name
input#1,SWFI,FIN$,SWFO,FOUT$   'switches and names for I/O ASCII files
input#1,SWT                     'switches for tide type
input#1,OPS                      'switch for printout interval
```

```
'
'--------------------------------------------------------------------------
'Read Input variables
'--------------------------------------------------------------------------
'
input#1,TITLE1$,TITLE2$,TITLE3$
'
input#1,DT,DX,IM,EDH,NM,NC,TOUT,TSTD
input#1,CF,CS,W,WPER
input#1,AMPL,msl,PER,MHHW,MLLW,MLHW,MHLW,NIQ
IF SWT = 0 THEN
        TideRange = 2*AMPL
ELSE
        TideRange = (MHHW-MLLW)*.3048
END IF
'
'%%
ltid=NM-(89280/dt)  'last tide
'%
FOR J = 1 TO NIQ
  input#1,CH(J),CHE(J),KM(J)
  I=ch(J):K=che(J)
  input#1,FRESH(I,K),TFLD(I,K),DUR(I,K)
NEXT J

'DLK  ADDED VELOCITY AND ELEVATION OUTPUT PLOT FILES

input #1, SVF,VFILE$,SZF,ZFILE$,NPTS,FREQ
FOR NP = 1 TO NPTS
  INPUT#1, IOUT(NP), KOUT(NP)
NEXT NP
'

IF SVF = 1 THEN
        OPEN VFILE$ FOR OUTPUT AS #5
        FOR J = 1 TO NPTS
          PRINT #5, USING "###,";IOUT(J);
          PRINT #5, USING "###   "; KOUT(J);
        NEXT J
        PRINT #5,'
END IF
'
IF SZF = 1 THEN
OPEN ZFILE$ FOR OUTPUT AS #6
        FOR J = 1 TO NPTS
          PRINT #6, USING "###,";IOUT(J);
          PRINT #6, USING "###   "; KOUT(J);
        NEXT J
```

```
            PRINT #6,
    END IF
    '
    K = 0
    FOR I = 0 TO IM
        print "i = ", i, "  k = ",k
        INPUT #1, WHL(I,K)
    NEXT
    '
    K = 0
    FOR I = 0 TO IM
        INPUT #1, WHH(I,K)
    NEXT
    '
        K = 0
    FOR I = 0 TO IM
      input #1, XSECL(I,K)
    NEXT I
    '
        K = 0
    FOR I = 0 TO IM
      input #1, XSECH(I,K)
    NEXT I
    '
    FOR J = 1 TO NIQ
        I = CH(J)
        FOR K = 1 TO KM(J)
          input #1, WHL(I,K)
        NEXT
    NEXT
    '
    FOR J = 1 TO NIQ
        I = CH(J)
        FOR K = 1 TO KM(J)
        input #1, WHH(I,K)
        NEXT
    NEXT
    '
    FOR J = 1 TO NIQ
        I = CH(J)
        FOR K = 1 TO KM(J)
          input #1, XSECL(I,K)
        NEXT
    NEXT
    '
    FOR J = 1 TO NIQ
        I = CH(J)
        FOR K = 1 TO KM(J)
          input #1, XSECH(I,K)
        NEXT
    NEXT
```

```
.ose #1
'
'----------------------------------------------------------------------
'Scale and Initialize Variables
'----------------------------------------------------------------------
'
if ops<1 or ops>im then ops=1
'
TSTD = TSTD * 3600.
TOUT = TOUT * 3600.
PER  = PER  * 3600.
'
FOR j = 1 to NIQ
    I = CH(J): K = CHE(J)
    DUR(I,K)    = DUR(I,K)*3600.
    TFLD(I,K)   = TFLD(I,K)*3600.
next j



k=0
FOR I = 0 TO IM
  U#(I,K) = 0. : UN#(I,K) = 0.
NEXT I
'
  R J = 1 TO NIQ
    I = CH(J)
    FOR K = 1 TO KM(J)
    U#(I,K) = 0: UN#(I,K) = 0
    NEXT : NEXT
'
TSXO = CS*W*ABS(W)                             ' wind stress
'

'----------------------------------------------------------------------
'  Read Initial Values from Input File
'----------------------------------------------------------------------
'
IF SWFI = 0 THEN GOTO NOTIN:
PRINT
'
OPEN FIN$ FOR INPUT AS #2
'
INPUT#2,N,T,TT
'
K = 0
FOR I = 1 TO IM
  INPUT#2,OZ#(I,K)
NEXT I
'
```

```
   R J = 1 TO NIQ
     I = CH(J)
     FOR K = 1 TO  KM(J)
     INPUT #2, OZ#(I,K)
     NEXT : NEXT
 '
 K = 0
 FOR I = 1 TO IM
   INPUT#2,U#(I,K)
 NEXT I
 '
 FOR J = 1 TO NIQ
     I = CH(J)
     FOR K = 1 TO KM(J)
     INPUT #2, U#(I,K)
     NEXT : NEXT
 '
 CLOSE #2
 NOTIN:
 '
 '
 open outfile1$ for output as #4
 '
 '-----------------------------------------------------------------------------
 'Do Initial Output (Title Page)
 '-----------------------------------------------------------------------------

IF SW1 = 1 THEN GOSUB TITLEPAGE:
GOSUB INITCOND:                         'CHECK INITIAL INPUT
IF SW2 = 1 THEN GOSUB OUTPRINT:
IF SVF = 1 THEN GOSUB VELOUT:
IF SZF = 1 THEN GOSUB ZOUT:
'

'=============================================================================
'
'                    LOOP FOR REPETATIVE TIME STEPPING
'
'=============================================================================
'
'open "monitor.fil" for output as #9
NEXTSTEP:
'close #9
'open "monitor.fil" for output as #9
'
'Increment step number and time
'------------------------------
N=N+1
T=T+DT
TT = TT + DT
print n;t;tt
```

```
'Turn on Wind
'------------
IF N<WPER/4 THEN TSX=TSXO*SIN(2*PI*N/WPER) ELSE TSX=TSXO
'
'
'---------------------------------------------------------------------------
'Calculate Water Surface Elevations (ref:SWL) at N+1.5
'---------------------------------------------------------------------------
'
'Calculate tidal elevations - Z(0)=Z(1)
'-------------------------------------
IF TT > PER THEN TT=TT-PER*(int(tt/per))
'
IF SWT = 1 THEN GOTO SYNDITIDE:
'
Z#(1,0)=AMPL*SIN(2*PI*T/PER) + msl                          'sine wave tide
GOTO GOTTIDE:
'
SYNDITIDE:
TH = TT/3600.                                        'synthetic diurnal tide
'
IF TH > 6.2 THEN GOTO CURVE2
  RNG = MHHW-MHLW
  Z#(1,0) = (-RNG/2.*COS(TH*PI/6.2)+MHLW+RNG/2.)*.3048
'(MHLW=>MHHW)
  GOTO GOTTIDE:

CURVE2:
IF TH > 12.4 THEN GOTO CURVE3:
  RNG = MHHW-MLLW
  Z#(1,0)=(RNG/2.*COS((TH-6.2)*PI/6.2)+RNG/2.+MLLW)*.3048
'(MHHW=>MLLW)
  GOTO GOTTIDE:
'
CURVE3:
IF TH > 18.6 THEN GOTO CURVE4:
  RNG = MLHW-MLLW
  Z#(1,0)=(-RNG/2.*COS((TH-12.4)*PI/6.2)+RNG/2.+MLLW)*.3048
'(MLLW=>MLHW)
  GOTO GOTTIDE:
'
CURVE4:
RNG = MLHW-MHLW
Z#(1,0) = (RNG/2.*COS((TH-18.6)*PI/6.2)+RNG/2.+MHLW)*.3048
'(MLHW=>MHLW)
'
GOTTIDE:
'
'---------------------------------------------------------------------------
'Driver for calculating z#,un#, and S#
```

```
'------------------------------------------------------------------------
gosub para0:
'
gosub para1:
'
gosub para2:
'
goto push:
'
'
'
'---------------------------------------------------------------------
'
PARA0:
'
k = 0
FOR I = 0 to IM
'  Interpolate between MHHW and MLLW
WH(I,K) = WHL(I,K)+ (OZ#(I,K)*(WHH(I,K)-WHL(I,K))/TideRange)
XSECZ(I,K) = XSECL(I,K)+OZ#(I,K)*XSECH(I,K)/TideRange
'  For water levels below MLLW:
IF OZ#(I,K) < 0 THEN
        WH(I,K) = WHL(I,K)
        XSECZ(I,K) = XSECL(I,K) + OZ#(I,K)*WHL(I,K)
        IF XSECZ(I,K) < 0.1 THEN XSECZ(I,K) = 0.1
  D IF
H(I,K) = XSECZ(I,K)/WH(I,K)-oz#(i,k)
NEXT
'
FOR J = 1 TO NIQ
    I = CH(J)
         FOR K = 1 TO KM(J)
'  Interpolate between MHHW and MLLW
         WH(I,K) = WHL(I,K)+OZ#(I,K)*(WHH(I,K)-WHL(I,K))/TideRange
         XSECZ(I,K) = XSECL(I,K)+OZ#(I,K)*XSECH(I,K)/TideRange
'  For water levels below MLLW:
        IF OZ#(I,K) < 0 THEN
                WH(I,K) = WHL(I,K)
                XSECZ(I,K) = XSECL(I,K) + OZ#(I,K)*WHL(I,K)
                IF XSECZ(I,K) < 0.1 THEN XSECZ(I,K) = 0.1
        END IF
         H(I,K) = XSECZ(I,K)/WH(I,K)-oz#(i,k)
    NEXT
NEXT
'
'
'Turn on freshwater flows
'-----------------------
FOR J = 1 TO NIQ
  I = CH(J)
```

```
   K = CHE(J)
   Q(I,K) = 0.
   IF T<=TFLD(I,K) THEN GOTO NOFLOOD:
   IF T>(TFLD(I,K)+DUR(I,K)) THEN GOTO NOFLOOD:
   Q(I,K) = FRESH(I,K)*.0438/WH(I,K)/DX
   NOFLOOD:
NEXT
'

'
'end of PARA0:
'
RETURN


PARA1:
'
'Calculate surface elevations for main channel - Z(i,0)
'-----------------------------------------------------------
'
J = 1
FOR I = 2 TO IM-1
  HIP = (H(I+1,0)+H(I,0)+OZ#(I+1,0)+OZ#(I,0))/2.
  WIP = (WH(I,0)+WH(I+1,0))/2
  HIM = (H(I,0)+H(I-1,0)+OZ#(I,0)+OZ#(I-1,0))/2.
  WIM = (WH(I,0)+WH(I-1,0))/2.

  Z#(I,0) = EDH*OZ#(I,0)+(OZ#(I+1,0)+OZ#(I-1,0))*(1-EDH)/2.
  Z#(I,0) = Z#(I,0)+DT*(Q(I,0)-(WIP*HIP*U#(I+1,0)-WIM*HIM*U#(I,0))/(WH(I,0)*D
))
'
' Calculate surface elevations for main channel junctions - Z(ch(j),0)
'------------------------------------------------------------------------
  IF I <> CH(J) THEN GOTO NOJUNCTION:
    HIS = (H(I,0)+H(I,1)+OZ#(I,0)+OZ#(I,1))/2.
    WIS = (DX+WH(I,1))/2
'
    z#(I,0) = z#(I,0) - dt*(wis*his*u#(I,1))/(wh(I,0)*dx)
    J=J+1
  NOJUNCTION:
NEXT I
'
'Set end cell elevation - Z(IM)=Z(IM,0)
'----------------------------------------
Z#(IM,0) = Z#(IM-1,0)
'
'
'Calculate surface elevations for branch channels - Z(CH(J),k)
'---------------------------------------------------------------
'
FOR J = 1 TO NIQ
```

```
  FOR K = 1 TO KM(J)-1
     I   = CH(J)
     HIP = (H(I,K+1)+H(I,K)+OZ#(I,K+1)+OZ#(I,K))/2.
     WIP = (WH(I,K)+WH(I,K+1))/2
     HIM = (H(I,K)+H(I,K-1)+OZ#(I,K)+OZ#(I,K-1))/2.
     WIM = (WH(I,K)+WH(I,K-1))/2.
'
     ZA# = EDH*OZ#(I,K)+(OZ#(I,K+1)+OZ#(I,K-1))*(1-EDH)/2.
     ZB# = DT*(Q(I,K)-(WIP*HIP*U#(I,K+1)-WIM*HIM*U#(I,K))/(WH(I,K)*DX))
     Z#(I,K) = ZA# + ZB#
   NEXT K
'
NEXT J
'
'Set end cell elevations for branch channels - Z(J,KM(J))
'--------------------------------------------------------------
'
FOR J = 1 TO NIQ
  Z#(CH(J),KM(J)) =  Z#(CH(J),KM(J)-1)
NEXT J
'
RETURN
'
'end of PARA1:
'
  RA2:

'Calculate velocities for main channel - UN(I,0)
'-----------------------------------------------------
FOR I = 2 TO IM-1
'if t > 59372 then
'  print #9, "T = "; t
'  print #9, "   i = ";i; "  Hi= ";H(i,0);"  Hi-1= ";H(i-1,0)
'  print #9, "         zi= ";z#(i,0);" zi-1= ";z#(i-1,0)
'end if
  HM = (H(I,0)+H(I-1,0)+Z#(I,0)+Z#(I-1,0))/2.
'if t > 41510 then print #9, "T = ";t, "i = ";i, "u#(i,0)  = ";u#(i,0)
  TBX = CF*U#(I,0)*ABS(U#(I,0))
  DELZ# = Z#(I,0)-Z#(I-1,0)
  UN#(I,0)  = U#(I,0)*EDH+(U#(I+1,0)+U#(I-1,0))*(1-EDH)/2.
  UN#(I,0)  = UN#(I,0)-DT*((U#(I+1,0)+U#(I,0))^2-(U#(I,0)+U#(I-1,0))^2)/8./DX
  UN#(I,0)  = UN#(I,0)  - DT*9.81*DELZ#/DX
  UN#(I,0)  = UN#(I,0)  + DT*(TSX-TBX)/HM
NEXT I
'
'Set mouth velocity - UN(1,0)
'-------------------------------
UN#(1,0)= UN#(2,0)+(Z#(1,0)-OZ#(1,0))*DX/(DT*(H(1,0)+Z#(1,0)))
'
'
```

```
 'alculate velocities for branch channels - UN(CH(I),K)
 '-------------------------------------------------------
 FOR J = 1 TO NIQ
   I = CH(J)

 ' Set mouth velocity at branch channel - UN(J,1)
 ' -----------------------------------------------
   K=1
         HM = (H(I,K)+H(I,K-1)+Z#(I,K)+Z#(I,K-1))/2.
 '       if t > 2900 then
 '               print #9, "t = "; t
 '               print #9, "i = "; "    j = ";j ; "    u#(i,k) = "; u#(i,k)
 '       end if
     TBX = CF*U#(I,K)*ABS(U#(I,K))
     DELZ# = Z#(I,K)-Z#(I,K-1)
     UN#(I,K) = U#(I,K)*EDH+(U#(I,K+1)+U#(I,K-1))*(1-EDH)/2.
     UN#(I,K) = UN#(I,K)-DT*((U#(I,K+1)+U#(I,K))^2-(U#(I,K)+0)^2)/8./DX
     UN#(I,K) = UN#(I,K) - DT*9.81*DELZ#/DX
     UN#(I,K) = UN#(I,K) + DT*(TSX-TBX)/HM

  FOR K = 2 TO KM(J)-1
    HM = (H(I,K)+H(I,K-1)+Z#(I,K)+Z#(I,K-1))/2.
    TBX = CF*U#(I,K)*ABS(U#(I,K))
    DELZ# = Z#(I,K)-Z#(I,K-1)
    UN#(I,K) = U#(I,K)*EDH+(U#(I,K+1)+U#(I,K-1))*(1-EDH)/2.
    UN#(I,K) = UN#(I,K)-DT*((U#(I,K+1)+U#(I,K))^2-(U#(I,K)+U#(I,K-1))^2)/8./D
    UN#(I,K) = UN#(I,K) - DT*9.81*DELZ#/DX
    UN#(I,K) = UN#(I,K) + DT*(TSX-TBX)/HM
  NEXT K
 '
 ' Set mouth velocity at branch channel - UN(J,1)
 ' -----------------------------------------------
 '  UN#(I,1)= UN#(I,2)+(Z#(I,1)-OZ#(I,1))*DX/(DT*(H(I,1)+Z#(I,1)))
 '
NEXT J
'
'
RETURN
'
'end of PARA2:
'
PUSH:
'
'
'------------------------------------------------------------------
'Push U, Z, and S values into time step N arrays
'------------------------------------------------------------------
K = 0
FOR I = 0 TO IM
'%%
  if N>=LTID then
```

```
  if TT=dt THEN
    LOWZ#(I,K)=Z#(I,K)
    LOWU#(I,K)=UN#(I,K)
    LOWZT(I,K)=T/3600.
    LOWUT(I,K)=T/3600.
  end if
  SELECT CASE Z#(I,K)
  CASE < LOWZ#(I,K)
    LOWZ#(I,K) = Z#(I,K)
    LOWZT(I,K) = T/3600.
  CASE > HIGHZ#(I,K)
    HIGHZ#(I,K) = Z#(I,K)
    HIGHZT(I,K) = T/3600.
  END SELECT
  SELECT CASE UN#(I,K)
  CASE < LOWU#(I,K)
    LOWU#(I,K) = UN#(I,K)
    LOWUT(I,K) = T/3600.
  CASE > HIGHU#(I,K)
    HIGHU#(I,K) = UN#(I,K)
    HIGHUT(I,K) = T/3600.
  END SELECT
  end if
'%
  IF I = 0 THEN GOTO SAL:
  U#(I,K)=UN#(I,K)
  OZ#(I,K)=Z#(I,K)
  SAL:
NEXT I
'
FOR J = 1 TO NIQ
    I = CH(J)
    FOR K = 1 TO KM(J)
'%%
  if N>=LTID then
  if TT=dt then
  LOWZ#(I,K)=Z#(I,K)
  LOWU#(I,K)=UN#(I,K)
  LOWZT(I,K)=T/3600.
  LOWUT(I,K)=T/3600.
  end if
  SELECT CASE Z#(I,K)
  CASE < LOWZ#(I,K)
    LOWZ#(I,K) = Z#(I,K)
    LOWZT(I,K) = T/3600.
  CASE > HIGHZ#(I,K)
    HIGHZ#(I,K) = Z#(I,K)
    HIGHZT(I,K) = T/3600.
  END SELECT
  SELECT CASE UN#(I,K)
  CASE < LOWU#(I,K)
```

```
      LOWU#(I,K) = UN#(I,K)
      LOWUT(I,K) = T/3600.
    CASE > HIGHU#(I,K)
      HIGHU#(I,K) = UN#(I,K)
      HIGHUT(I,K) = T/3600.
    END SELECT
    end if
 '%
 '
     U#(I,K) = UN#(I,K)
     OZ#(I,K) = Z#(I,K)
     NEXT
 NEXT
 '
 'end of PUSH:
 '
 CHECK:
 '
 '---------------------------------------------------------------------------
 'Check NC to Repeat Loop at t+dt or Calculate Kinetic Energy/Check NM
 '---------------------------------------------------------------------------
 '
 'Check step number - do next step, output, or check KE
 '----------------------------------------------------------
 IF SVF = 1 THEN GOSUB VELOUT:
 IF SZF = 1 THEN GOSUB ZOUT:
    N = NM THEN GOSUB OUTFILE:
 if n = nm then goto KICKOUT:
 IF T = TSTD THEN GOSUB OUTFILE:
 IF T < TOUT THEN GOTO NEXTSTEP:
 IF N/NC <> INT(N/NC) THEN GOTO NEXTSTEP:
 '
 'Calculate total kinetic energy
 '-----------------------------
 KK=EK
 EK=0
 K = 0
 '
 FOR I = 1 TO IM-1
   EK = EK+(U#(I,K))^2*H(I,K)
 NEXT I
 '
 FOR J = 1 TO NIQ
     I = CH(J)
     FOR K = 1 TO KM(J)
     EK = EK + (U#(I,K)^2*H(I,K))
     NEXT
 NEXT
 '
 'Do output and check for end
 '--------------------------
```

```
`SUB OUTFILE:

IF N<NM THEN GOTO NEXTSTEP:
'
KICKOUT:
close #4
close #5
close #6
'print #8, "MODEL: "; datafile$; "; run complete on "; date$; " at "; time$
wend
close #7
'close #8
END


'
'========================================================================
'
'                        OUTPUT ROUTINES
'
'========================================================================
'
TITLEPAGE:
'PAGE 1 - SW1=1
'--------------
'
  INT#4, TITLE1$ :print#4,
PRINT#4, TITLE2$
PRINT#4, TITLE3$
PRINT#4, :print#4,
'
PRINT#4, "Time Step (DT)                    =";DT
PRINT#4, "Space Step (DX)                   =";DX
PRINT#4, "Time Step ehd                     =";:PRINT#4, USING "  #.##";EDH

PRINT#4, "Bed Friction (CF)                 =";:PRINT#4, USING "  #.###";CF
PRINT#4, "Wind Velocity                     =";W
PRINT#4, "Wind Period                       =";WPER
PRINT#4, "Surface Friction (CS)             =";CS

PRINT#4, "Tide Amplitude                    =";AMPL
PRINT#4, "Tide Period                       =";:PRINT#4, USING " ###.# ";PER/3600.

FOR J = 1 TO NIQ
    I = CH(J): K = CHE(J)
  PRINT#4, "Discharge Grid Index              =";:PRINT#4, USING "  ### ";CH(J),CHE(
)
  PRINT#4, "Discharge Start Time              =";:PRINT#4, USING "  ##.# ";TFLD(I,K)
3600.
  PRINT#4, "Discharge Rate                  - =";:PRINT#4, USING " ###.# ";fresh(i,k
  PRINT#4, "Discharge Duration                =";:PRINT#4, USING " ###.#";DUR(I,K)/3
```

```
-0.
  PRINT#4,
NEXT J
PRINT#4,
'
'
print#4, "---------------------------------"
print#4, "Run Date was: ";date$
print#4, "Run Time was: ";time$
print#4, "Data File Used was:       ";datafile$
print#4, "Input Start-up File was: ";fin$
print#4, "Output File was:          ";fout$
'
PRINT#4, CHR$(12)
'
'%
RETURN
'
'---------------------------------------------------------------------------
'Write elevation, velocity, and salinty fields to ASCII files
'---------------------------------------------------------------------------
'
OUTFILE:
IF SWFO = 0 THEN GOTO OUTPRINT:
IF SWFO=1 AND n<nm THEN GOTO OUTPRINT:
'
 'EN FOUT$ FOR OUTPUT AS #3

PRINT#3,N,T,TT
'
K = 0
FOR I = 1 TO IM
  PRINT#3,OZ#(I,K)
NEXT I
'
FOR J = 1 TO NIQ
    I = CH(J)
    FOR K = 1 TO  KM(J)
    PRINT #3, OZ#(I,K)
    NEXT : NEXT
'
K = 0
FOR I = 1 TO IM
  PRINT#3,U#(I,K)
NEXT I
'
FOR J = 1 TO NIQ
    I = CH(J)
    FOR K = 1 TO KM(J)
    PRINT #3, U#(I,K)
    NEXT : NEXT
```

```
)SE #3
'
'

'-------------------------------------------------------------------------
'Printout elevation, velocity, and salinty fields
'-------------------------------------------------------------------------
'
OUTPRINT:
IF SW2 = 0 THEN GOTO NOPRINT:
if cnt <> 0 then goto skiphead:
pn = pn+1
print#4, title1$:print#4, title2$:print#4, title3$
print#4, "Page";pn
print#4,:print#4,
SKIPHEAD:
'
'Printout header for output step
'------------------------------

print#4, "Step=";:print#4, using "######";N;
print#4, "   Time=";:print#4, using "####.## ";T/3600.;
print#4, "   Tide Time=";:print#4, using "###.## ";TT/3600.;
print#4, "   KE=";:print#4, using "####.####    ";EK
'
  INT#4,

'Printout elevation, velocity, and salinity
'----------------------------------------
K= 0
PRINT #4, "MAIN CHANNEL"
PRINT#4, "C ";
FOR I=1 TO IM STEP OPS:PRINT#4, USING " ###     ";I    ;:NEXT I:PRINT#4,
PRINT#4, "Z ";
FOR I=1 TO IM STEP OPS:PRINT#4, USING " ###.###";OZ#(I,K);:NEXT I:PRINT#4,
PRINT#4, "U ";
FOR I=1 TO IM STEP OPS:PRINT#4, USING " ###.###";U#(I,K);:NEXT I:PRINT#4,
PRINT#4,:PRINT#4,

PRINT #4, "SECONDARY CHANNELS":print#4,
FOR J = 1 TO NIQ
    I = CH(J)
    print#4, "Channel Entering at :";ch(j);"0":PRINT#4,"C ";
FOR K = 1 TO KM(J) STEP OPS:PRINT#4, USING " ###     ";K    ;:NEXT K:PRINT#4,
PRINT#4, "Z ";
FOR K=1 TO KM(J) STEP OPS:PRINT#4, USING " ###.###";OZ#(I,K);:NEXT K:PRINT#4,
PRINT#4, "U ";
FOR K=1 TO KM(J) STEP OPS:PRINT#4, USING " ###.###";U#(I,K);:NEXT K:PRINT#4,
PRINT#4,:PRINT#4,
NEXT
```

```
nt = 0
if cnt=0 then print#4,chr$(12)
if n=nm then
'%%
PRINT#4, "       MINIMUM AND MAXIMUM Z, U, S OF THE SIMULATION"
PRINT#4, "               ELEVATION         VELOCITY          SALINITY"
PRINT#4, "    CELL     MIN     MAX      MIN     MAX       MIN     MAX"
PRINT#4, "    ____     ___     ___      ___     ___       ___     ___"
K=0
FOR I=0 TO IM
PRINT#4, "    ";
PRINT#4, USING "##";I;
PRINT#4, ",";
PRINT#4, USING "##";K;
PRINT#4, USING " ####.# ";LOWZ#(I,K),HIGHZ#(I,K),LOWU#(I,K),HIGHU#(I,K)
NEXT
PRINT#4,
PRINT#4, "   TIME OF MINIMUM AND MAXIMUM Z, U, S OF THE SIMULATION"
PRINT#4, "               ELEVATION         VELOCITY          SALINITY"
PRINT#4, "  CELL       MIN     MAX      MIN     MAX       MIN     MAX"
PRINT#4, "  ____       ___     ___      ___     ___       ___     ___"
K=0
FOR I=0 TO IM
PRINT#4, "    ";
PRINT#4, USING "##";I;
PRINT#4, ",";
PRINT#4, USING "##";K;
PRINT#4, USING " ###.## ";LOWZT(I,K),HIGHZT(I,K);
PRINT#4, USING " ###.## ";LOWUT(I,K),HIGHUT(I,K)
NEXT
'
FOR J = 1 TO NIQ
  I = CH(J)
PRINT#4, "       MINIMUM AND MAXIMUM Z, U, S OF THE SIMULATION"
PRINT#4, "               ELEVATION         VELOCITY          SALINITY"
PRINT#4, "    CELL     MIN     MAX      MIN     MAX       MIN     MAX"
PRINT#4, "    ____     ___     ___      ___     ___       ___     ___"
FOR K = 1 TO KM(J)
PRINT#4, "    ";
PRINT#4, USING "##";I;
PRINT#4, ",";
PRINT#4, USING "##";K;
PRINT#4, USING " ####.# ";LOWZ#(I,K),HIGHZ#(I,K),LOWU#(I,K),HIGHU#(I,K)
NEXT
PRINT#4,
PRINT#4, "   TIME OF MINIMUM AND MAXIMUM Z, U, S OF THE SIMULATION"
PRINT#4, "               ELEVATION            VELOCITY "
PRINT#4, "  CELL       MIN     MAX        MIN     MAX"
PRINT#4, "  ____       ___     ___        ___     ___"
FOR K = 1 TO KM(J)
PRINT#4, "    ";
```

```
PRINT#4, USING "##";I;
PRINT#4, ",";
PRINT#4, USING "##";K;
PRINT#4, USING " ###.## ";LOWZT(I,K),HIGHZT(I,K);
PRINT#4, USING " ###.## ";LOWUT(I,K),HIGHUT(I,K)
NEXT
PRINT#4, CHR$(12)
NEXT
PRINT#4, CHR$(12)
end if
'%
NOPRINT:
RETURN

VELOUT:

'   WRITE VELOCITY DATA FOR SELECTED CELLS TO OUTPUT FILE

IF N/FREQ <> INT(N/FREQ) THEN RETURN
PRINT #5, T;
FOR J=1 TO NPTS
        PRINT #5, U#(IOUT(J),KOUT(J));
NEXT J
PRINT #5,

RETURN

ZOUT:

'   WRITE ELEVATION DATA FOR SELECTED CELLS TO OUTPUT FILE

IF N/FREQ <> INT(N/FREQ) THEN RETURN
PRINT #6, T;
FOR J = 1 TO NPTS
        PRINT #6, OZ#(IOUT(J),KOUT(J));
NEXT J
PRINT #6,

RETURN
'===========================================================================

'CHECK INITIAL MODEL DEFINITION
'==============================

INITCOND:
'
PRINT #4, "  I", "  K",  "  WHL", "  WHH", "  XSECL", "  XSECH"
PRINT #4,
K = 0
FOR I = 0 TO IM
```

```
        PRINT #4, I,K,WHL(I,K), WHH(I,K), XSECL(I,K), XSECH(I,K)
  NEXT I
PRINT #4,
FOR J = 1 TO NIQ
  I = CH(J)
  FOR K = 1 TO CHE(J)
         PRINT #4, I,K,WHL(I,K), WHH(I,K), XSECL(I,K), XSECH(I,K)
  NEXT K
PRINT #4,
NEXT J

RETURN
```

Preliminary Results from Seal Beach Wildlife Refuge Study

Background
- ROD
- Species in NWR
- SI

Approach
- Phased
- Phase I sampling
  - Components
    - watershed characterization
      - Storet data and map
    - physical oceanography
      - map with pre and post POLB erosion/sedimentation patterns
    - sediment and biota sampling
      - list of chemical of concern
      - map??

Results

- need for overheads:
  - watershed map
  - sampling map for sediment and biota
  - map showing sediment transport

What are chemicals from sites 8, 44 etc

Appendix C

EVALUATION OF SEAL BEACH NATIONL WILDLIFE REFUGE

SEDIMENT CHEMISTRY DATA

Appendix C

EVALUATION OF SEAL BEACH NATIONAL WILDLIFE REFUGE SEDIMENT CHEMISTRY DATA

Prepared by Don Heinle

INTRODUCTION

Sediment samples were collected from Seal Beach National Wildlife Refuge (NWR) on 24 through 26 October 1992. The purpose of the sampling was to characterize possible contamination in the NWR sediments as described in the Final Work Plan (Navy 1992) as part of the Wildlife Refuge Study, which was intended to assess the impacts of operations of Naval Weapons Station (NWS) Seal Beach on the NWR.

Methods

To evaluate existing conditions in the NWR, sediment samples were collected over a grid of 22 sample locations within the NWR, and one sample location at the mouth of Huntington Harbour, just outside of the NWR (see Figure 2, Appendix D). Sample locations were selected to provide information on the distribution of contaminants in the NWR by including locations in major channels, as well as near previously identified contaminant sites.

Sediment samples were collected in October 1992 in tidal channels immediately adjacent to the sample location identified for biota collection (see Appendix D) on the tidal flat. Samples were collected with a Ponar dredge or shovel from an inflatable boat. At the time of collection, stratification and texture were noted.

At each sample location, a minimum of 200 grams of sediment was collected in a whirl-pak® container for total metals analysis, a minimum of 400 grams was collected in an I-Chem bottle for organics analysis, and a minimum of 100 grams was collected in separate I-Chem bottles for Total Organic Carbon analysis and acid volatile sulfide analysis.

From among the 23 samples, two split samples were obtained for each analysis. Two field duplicates for each analysis were obtained from sample locations not used for split samples. Two samples with sufficient volumes of sediment were designated for use for matrix-spike duplicates (MSDs). Samples were initially stored on ice, then frozen awaiting permission from US Fish and Wildlife Service (USFWS) to ship them to their contract laboratory (see Deviations from Work Plan below).

Analyses were conducted by Geochemical and Environmental Research Group (GERG), a contract laboratory of the USFWS, following the National Oceanic and Atmospheric Administration (NOAA) status and trends methods described in Appendix B of the Final Work Plan (Navy 1992). For organics analysis, the samples were extracted and cleaned up before analysis by gas chromatography/mass spectrometry (GC/MS). Target detection limits were 5 nanograms per gram (ng/g) (or 0.005 milligrams per kilograms [mg/kg]) for individual Polynuclear Aromatic Hydrocarbons (PAHs) and 2 ng/g (or 0.002 mg/kg) for individual pesticides or polychlorinated biphenyls (PCBs) when levels of contamination were low; in samples with high levels of contamination the target detection limits were 60 times those values. Most metals were analyzed by inductively coupled plasma emission spectroscopy following sample digestion. However, lead was analyzed by graphite furnace atomic absorption spectroscopy (AA) and mercury by cold vapor reduction AA. Target detection limits were as follows: 4 mg/kg lead; 3 mg/kg silver; 1 mg/kg barium; 0.6 mg/kg copper; 0.5 mg/kg arsenic, chromium, nickel, and selenium; 0.2 mg/kg zinc; and 0.1 mg/kg cadmium and mercury.

Quality assurance/quality control (QA/QC) for the chemical analyses was provided by the USFWS in accordance with that agency's existing contract with GERG. Method blanks were run with every 20 samples or with every sample set, whichever was more frequent. Blank levels were acceptable if they were no more than 3 times the method detection limit (MDL). Matrix spike/matrix spike duplicate (MS/MSD) samples were run at the same frequency as method blanks with the spiking level between 3 and 10 times the MDL. Surrogate materials were added (spiked) to each sample (including QC samples) at levels between 3 and 10 times the MDL. In addition, standard reference materials were analyzed at a frequency of one per sample batch (or 20 samples). Criteria for acceptance of analytical results are discussed in Appendix B of the Final Work Plan (Navy, 1992).

Analyses were evaluated based on a 1993 draft report titled "Criteria to Rank Toxic Hot Spots in Enclosed Bays and Estuaries of California," provided by The State of California, State Water Resources Control Board, Division of Water Quality. That report includes a table of sediment screening levels developed by the NOAA (Long and Morgan, 1990) and by the State of Florida (1993) (reproduced as Table 1). The concentrations of contaminants found at the NWR are compared with the concentrations in Table 1 to provide perspective on the magnitude of contamination at the NWR. In addition to the values in Table 1, metal results from the NWR are also compared with a list of regional background concentrations compiled from several sources.

Samples were stored on ice after collection, but problems in coordination with the USFWS caused delays in shipping to the laboratories. When it became apparent that holding times for unfrozen samples would be exceeded, the samples for sediment chemistry were frozen and held in that condition until after delivery to the laboratories.

Data Evaluation

Data quality objectives for accuracy, precision, and completeness are described and summarized in Tables 7-2 and 7-3 in the Final Work Plan. The completeness objective of 90 percent was achieved. Accuracy and precision objectives were met in all instances where analyte concentrations exceeded detection limits by factors of two or more. When analyte concentrations were near detection limits, accuracy as measured by MSs and

Table 1
Comparison of Sediment Screening[1] Levels Developed by NOAA (Long and Morgan, 1990) and the State of Florida (1992) (from State of California, 1993)

Substance	NOEL[2]	ERL[3]	PEL[4]	ERM[5]
Organics in ug/kg or ppb				
Total PCBs	25	50	270	380
Acenaphthene	22	150	450	650
Anthracene	85	85	800	960
Fluorene	18	35	460	640
2-methyl naphthalene		65		670
Naphthalene	130	340	1,100	2,100
Phenanthrene	140	225	1,200	1,380
Total LMW-PAHs	250		2,400	
Benz(a)anthracene	160	230	1,300	1,600
Benao(a)pyrene	220	400	1,700	2,500
Chrysene	220	400	1,700	2,800
Dibenzo(a,h)anthracene	31	60	320	260
Fluoranthene	380	600	3,200	3,600
Pyrene	290	350	1,900	2,200
Total HMW-PAHs	875		8,500	
Total PAHs	2,900	4,000	28,000	35,000
p,p'-DDE	1.7	2	130	15
Total DDT	4.5	3	270	350
Metals in mg/kg or ppm				
Arsenic	8	33	64	85
Cadmium	1	5	7.5	9
Chromium	33	80	290	145
Copper	28	70	170	390
Lead	21	35	160	110
Mercury	0.15	0.15	1.4	1.3
Nickel	15	30	50	50
Silver	0.5	2.5	2.5	2.2
Zinc	68	300	300	270

[1]Values are for bulk sediment chemistry on a dry weight basis.
[2]NOEL is defined as the sediment concentration below which adverse effects are not likely to occur. The value is derived by taking the geometric mean of 15th percentile of the effects database and the 50th percentile of the no-effects database and dividing by a safety factor of 2.
[3]The ER-L is analogous to the NOEL. It is the concentration below which adverse effects are seldom expected. It is developed by taking the 10th percentile of the ranked adverse effects data in the Long and Morgan database.
[4]PEL is that concentration above which adverse biological effects are likely to occur. It is developed by taking the geometric mean of the 50th percentile value of the effects database and the 85th percentile value of the no-effects database.
[5]The ER-M is analogous to the PEL. It is that concentration above which adverse effects are likely. It is developed by taking the 50th percentile of the ranked adverse effects data in the Long and Morgan database.

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precision as measured by relative percent difference (RPD) of duplicate analysis were sometimes outside the objectives listed in Tables 7-2 and 7-3 of the work plan.

MS recoveries were high (never low) for most PAHs in two of three spiked samples. That occurred when the MS amount was similar to the background amount (which for all three MS samples was near or below detection limits). Results for PAH at concentrations near the detection limits are biased high.

MS limits (targets are average for all compounds) were barely exceeded for one pesticide, oxychlordane, in one of the three spiked samples, indicating that the pesticide data are not biased.

Precision, as measured by RPD of duplicate samples, was also adversely affected by the fact that analyte concentrations were near or below detection limits. However, for most compounds, even though the analyte concentrations were less than 2 times the detection limits, the target RPD of less than 40 percent for concentrations of 2 to 10 times detection limits was met. The only compounds with RPD greater than 40 percent were total PCBs, benzo(b)fluoranthene, chrysene, and 4,4[1] DDE.

Precision, accuracy, and completeness objectives were not set for metals, but analysis of laboratory duplicates resulted in RPDs of about 10 percent or less.

All data are considered usable for the purpose of evaluating the possible contaminants at the NWR, but the high bias of the PAH data should be considered.

Results

Concentrations of arsenic, chromium, copper, lead, nickel, silver, and zinc in some samples exceeded the no-observed effects levels (NOEL) (State of California, 1993) (Table 1). Silver barely exceeded the NOEL of 0.5 mg/kg in one sample, a field duplicate at Sample Location E-3. Some concentrations of lead, nickel, and zinc also exceeded the effects range low (ERL) of NOAA (Table 1). Exceedances of the ERL were most common for zinc although the highest concentration of zinc observed (210 mg/kg) was only 3 times the NOEL and less than 2 times the ERL. Similarly, the highest concentrations of lead and nickel were about 3 times the NOEL.

The highest concentrations of arsenic, chromium, and copper were about 2 times the NOEL, and in many samples the concentrations of those metals barely exceeded the NOEL. Note that a safety factor of two was applied in deriving the NOELs (Table 1). Concentrations of metals, acid volatile sulfide, and total organic carbon (TOC) observed in sediment from Seal Beach NWR are shown in Table 2. Aluminum, iron, and manganese are not contaminants of concern. They are included in Table 2 because they are useful for interpreting the data on other metals with regard to whether concentrations observed represent contamination or natural (geologic) background. Background concentrations for

Table 2
Concentrations of Metals and Sulfide (mg/kg dry weight) and Total Organic Carbon (TOC, in percent) in Sediments from Seal Beach NWR

Station Name	Sample Name	Aluminum	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Nickel	Silver	Zinc	Sulfide	TOC
A1	1SB	29,200	9.50 a	0.200 U	58.0 a	67.1 a	48,600	38.4 b	681	48.9 b	0.350 U	172 b	50.4	2.36
B1	2SB	23,900	11.0 a	0.450	47.7 a	54.2 a	39,600	52.5 b	464	37.4 b	0.350 U	210 b	728	1.87
B2	3SB	8,930	4.50	0.200 U	16.2	17.1	19,200	26.0 a	196	13.2	0.350 U	73.4 a	322	0.710
C1	4SB	11,000	6.30	0.200 U	21.8	19.4	26,500	15.1	328	17.4 a	0.350 U	77.1 a	34.0	0.380
C2	24SB	18,400	11.9 a	0.250	36.3 a	38.8 a	39,000	30.9 a	476	30.4 b	0.350 U	152 b	60.3	1.29
C2	5SB	21,000	11.0 a	0.240	38.8 a	39.8 a	39,700	31.2 a	546	34.5 b	0.350 U	148 b	81.4	0.750
C3	6SB	23,900	7.30	0.200 U	45.3 a	52.4 a	45,700	32.6 a	534	33.0 b	0.350 U	197 b	1,950	1.95
C4	7SB	22,200	8.00	0.210	37.8 a	44.5 a	38,900	31.1 a	543	30.5 b	0.350 U	168 b	1,050	1.14
D1	8SB	15,700	6.70	0.200 U	24.1	26.2	27,200	20.6	365	19.4 a	0.350 U	102 a	78.5	0.590
D2	9SB	24,700	14.4 a	0.200 U	45.6 a	41.1 a	36,100	23.5 a	502	32.1 b	0.350 U	156 b	143	1.37
D3	10SB	16,700	12.5 a	0.200 U	36.2 a	36.7 a	38,700	32.1 a	528	28.3 a	0.350 U	133 b	175	1.55
E1	11SB	11,800	6.05	0.200 U	27.6	30.4 a	26,300	24.6 a	319	20.7 a	0.350 U	112 a	636	0.890
E2	12SB	21,000	11.2 a	0.200 U	40.1 a	33.3 a	33,500	23.6 a	464	28.0 a	0.350 U	130 b	420	0.590
E3	13SB	14,100	7.40	0.200 U	30.7	36.9 a	27,600	28.3 a	368	22.6 a	0.350 U	170 b	275	1.00
E3	29SB	21,300	6.50	0.200 U	30.4	36.8 a	29,500	26.9 a	389	21.5 a	0.740 a	144 b	201	1.17
E4	14SB	18,500	17.5 a	0.200 U	44.8 a	49.6 a	45,500	28.0 a	527	35.7 b	0.350 U	148 b		3.01
E4	26SB	23,600	13.7 a	0.200 U	41.6 a	49.8 a	47,000	25.7 a	496	31.7 b	0.350 U	158 b	77.4	2.41
F1	15SB	9,300	5.20	0.200 U	19.2	18.6	17,800	19.7	235	14.5	0.350 U	72.7 a	188	0.580
F1	25SB	10,700	5.10	0.200 U	17.7	16.9	19,800	17.7	234	12.2	0.350 U	73.1 a	82.6	1.05
F2	16SB	15,000	6.40	0.200 U	32.3	35.1 a	27,300	26.4 a	369	23.4 a	0.350 U	131 b	714	1.05
F2	28SB	17,600	6.00	0.200 U	29.2	33.8 a	29,700	24.9 a	364	20.7 a	0.350 U	140 b		1.02
F3	17SB	10,300	5.50	0.200 U	21.5	19.3	16,700	20.6	240	14.5	0.350 U	73.4 a	399	0.720
F4	18SB	15,700	8.20 a	0.200 U	35.7 a	36.4 a	29,100	26.2 a	382	25.5 a	0.350 U	120 a	456	1.02
F5	19SB	14,400	5.60	0.200 U	28.7	22.3	21,500	19.7	309	18.7 a	0.350 U	80.9 a	197	0.270
F5	27SB	15,400	4.30	0.200 U	23.5	22.7	28,000	20.7	370	16.7 a	0.350 U	99.0 a	204	0.230
G1	20SB	13,800	11.2 a	0.200 U	31.2	28.5 a	29,200	16.3	361	25.0 a	0.350 U	88.3 a	30.1	1.94
G2	21SB	7,360	4.60	0.200 U	16.1	19.7	13,700	19.9	187	12.3	0.350 U	67.3	83.2	0.630
G3	22SB	15,400	5.70	0.200 U	34.0 a	35.3 a	29,600	25.0 a	399	24.9 a	0.350 U	135 b	657	0.660
H1	23SB	6,920	3.00	0.200 U	14.1	11.6	11,300	17.4	168	10.3	0.350 U	48.3	85.9	0.170

a Exceeds the NOEL sediment screening standard
b Exceeds the ERL sediment screening standard
U undetected. Value equals detection limit.

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metals in the Southern California Bight, obtained or derived from several sources, are shown in Table 3. These are reasonable geologic background values. Note that for arsenic and nickel, the regional background values are higher than the NOELs (Table 1) and very similar to the concentrations at the NWR that exceeded the NOELs (Table 2).

Given the small range of concentrations of the metals, gradients in concentrations were not apparent. In addition, metal concentrations may be related to sediment grain size and TOC, being lower in sandy sediments with low TOC. However, the three highest concentrations of chromium, copper, lead, and zinc usually were observed at three Sample Locations: A-1, B-1, and C-3, and nickel was highest at A-1, B-1, and E-4 (Table 2).

PAHs were observed at several locations at concentrations near detection limits as shown in Table 4. Highest concentrations of individual compounds and of total PAHs were found at Sample Locations D1, B1, and E1; all these sample locations are in the west arm of the NWR. Sample Location C1, between Sample Locations D1 and E1, had no detected PAHs. Total PAHs were calculated using 0.5 times the detection limits for nondetected compounds. This was done because the presence of some PAHs indicated that others were probably present at concentrations below the detection limits.

All PAH concentrations were below the NOELs (Table 1) and so are not expected to have adverse biological effects.

Detection limits for pesticides and PCBs were consistently higher than the NOELs and ERLs (Table 1); therefore, whenever pesticides or PCBs were detected (Table 4), their concentrations exceeded both the NOELs and the ERLs.

Total PCBs were detected only in one of two laboratory duplicate analyses at Sample Location C-3. Metabolites of DDT (4,4′-DDD and 4,4′-DDE) were detected at several locations with 4,4′-DDE being widespread in the NWR. Total DDT (Table 4) was calculated using 0.5 times the detection limit for nondetected compounds. Concentrations of DDT were highest at Sample Location B-1 where 0.181 mg/kg of 4,4′-DDE were observed and 4,4′-DDD was also detected. Sample Locations B-2 and C-2 had the second and third highest concentrations of 4,4′-DDE, with 4,4′-DDD detected in one of two duplicate samples from C-2. As noted earlier, detection limits for DDTs were higher than the NOELs and ERLs (Table 1).

The detected concentration of the 4,4′-DDE at Sample Location B-1 was above the probable effects level (PEL) of 0.130 ppm (Table 1). Concentrations at other locations where 4,4-DDE was detected (Table 4) were one-fifth to one-sixth of the PEL, but generally over the ERM. Since the ERM for 4,4′-DDE is lower than the PEL, it was exceeded in 17 of the 19 samples where 4,4′-DDE was detected.

Table 3
Regional Background Concentrations of Metals in Offshore Sediments

Metal	Background[1,2,3,4] Concentrations (mg/kg dry weight)
Arsenic	10[1]
Barium	490[2]
Beryllium	6[3]
Cadmium	0.55[4] (0.4[1])
Cobalt	8[3]
Chromium	29.7[4,5]
Copper	6.94[4], 10[1]
Iron	19,000 to 30,000[4]
Lead	6.02[4], 10[1]
Mercury	0.05[1]
Nickel	23.2[4]
Selenium	0.2 to 0.3 up to 1.0[1]
Silver	0.51[4], 0.01 to 0.1[1]
Tin	1.18 to 11.06[6]
Vanadium	103[4]
Zinc	44.6[4], 40 to 60[1]

[1]From Mearns et al. (1991).
[2]Calculated from data in Katz and Kaplin (1981).
[3]From Lindsay (1979).
[4]From Katz and Kaplin (1981).
[5]Could be lower in bays and harbors according to Mearns et al. (1991).
[6]From Anderson, Bay, and Thompson (1988); Los Angeles and Long Beach harbors.

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Table 4
Concentrations of Organic Constituents in Sediments from Seal Beach NWR

Station Name	Sample Name	Naphthalene	Acenaphthalene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)-anthracene	Chrysene	Perylene
		POLYCYCLIC AROMATIC HYDROCARBONS (All values have units of ppb (ug/kg) dry weight)										
A1	1SBPP	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U
B1	2SBPP	9.51 U	9.51 U	9.51 U	9.51 U	32.2	9.51 U	54.3	54.3	24.1	44.2	16.1
B2	3SBPP	9.45 U	9.45 U	9.45 U	9.45 U	9.45 U	9.45 U	19.2	22.0	11.0	15.1	20.6
C1	4SBPP	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U
C2	24SBPP	11.6 U	11.6 U	11.6 U	11.6 U	11.6 U	11.6 U	21.2	24.1	12.5	23.1	11.6 U
C2	5SBPP	9.79 U	9.79 U	9.79 U	9.79 U	9.79 U	9.79 U	22.6	26.4	11.3	22.6	9.79 U
C3	6SBPP	9.29 U	9.29 U	9.29 U	9.29 U	9.29 U	9.29 U	24.0	24.0	10.9	24.0	9.29 U
C4	7SBPP	9.53 U	9.53 U	9.53 U	9.53 U	9.53 U	9.53 U	17.8	19.7	9.87	19.7	9.53 U
D1	8SBPP	9.41 U	9.41 U	13.2	9.41 U	72.7	23.1	101	97.4	44.6	54.5	13.2
D2	9SBPP	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	16.7	13.9	9.57 U	11.2	27.9
D3	10SBPP	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	11.0	9.96 U	11.0	9.96 U
E1	11SBPP	9.10 U	9.10 U	9.10 U	9.10 U	12.1	15.6	43.3	52.0	20.8	34.7	13.9
E2	12SBPP	9.77 U	9.77 U	9.77 U	9.77 U	9.77 U	9.77 U	10.2	10.2	9.77 U	9.77 U	9.77 U
E3	13SBPP	9.55 U	9.55 U	9.55 U	9.55 U	9.55 U	9.55 U	12.6	14.4	9.55 U	12.6	9.55 U
E3	29SBPP	9.46 U	9.46 U	9.46 U	9.46 U	9.46 U	9.46 U	15.5	17.3	9.46 U	15.5	9.46 U
E4	14SBPP	9.79 U	9.79 U	9.79 U	9.79 U	9.79 U	9.79 U	12.9	15.4	9.79 U	9.79 U	9.79 U
E4	26SBPP	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U	15.1	15.1	12.5 U	12.5 U	12.5 U
F1	15SBPP	9.91 U	9.91 U	9.91 U	9.91 U	9.91 U	9.91 U	16.3	15.6	9.91 U	12.7	9.91 U
F1	25SBPP	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U	12.8	11.2	9.88 U	9.88 U	9.88 U
F2	16SBPP	9.74 U	9.74 U	9.74 U	9.74 U	9.74 U	9.74 U	17.1	17.1	10.2	11.9	9.74 U
F2	28SBPP	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	19.7	17.9	9.96 U	17.9	9.96 U
F3	17SBPP	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U
F4	18SBPP	9.86 U	9.86 U	9.86 U	9.86 U	9.86 U	9.86 U	12.1	13.9	9.86 U	12.1	9.86 U
F5	19SBPP	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
F5	27SBPP	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U
G1	20SBPP	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U
G2	21SBPP	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	24.1	20.9	11.3	20.9	9.81 U
G3	22SBPP	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	10.3	12.1	9.81 U	10.3	9.81 U
H1	23SBPP	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U

a Exceeds the ERL sediment screening standard
b Exceeds the PEL sediment screening standard
U Undetected. Value equals detection limit.
J Estimated. Below CRDL and above IDL/MDL

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Table 4
Concentrations of Organic Constituents in Sediments from Seal Beach NWR

		POLYCYCLIC AROMATIC HYDROCARBONS (Units are ppb (ug/kg) dry weight)							PESTICIDES			
Station Name	Sample Name	Benzo(b)-fluoranthene	Benzo(k)-fluoranthene	Benzo(e)-pyrene	Benzo(a) pyrene	Indeno(1,2,3-cd) pyrene	Dibenzo(a,h)-anthracene	Benzo(ghi)-perylene	4,4'-DDD	4,4'-DDE	4,4'-DDT	O,P'-DDT
A1	1SBPP	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	9.63 U	18.3 a	9.63 U a	9.63 U
B1	2SBPP	26.1	28.1	30.2	26.1	14.1	9.51 U	16.1	40.2	181 b	9.51 U a	9.51 U
B2	3SBPP	11.0	11.0	27.5	12.4	9.45 U	9.45 U	9.45 U	27.5	27.5 a	9.45 U a	9.45 U
C1	4SBPP	8.98 U	8.98 U	8.98 U	9.0 U	8.98 U	8.98 U	8.98 U	8.98 U	8.98 U a	8.98 U a	8.98 U
C2	24SBPP	16.4	15.4	15.4	15.4	11.6 U	11.6 U	13.5	11.6 U	19.3 a	11.6 U a	11.6 U
C2	5SBPP	15.1	15.1	15.1	13.2	9.79 U	9.79 U	11.3	18.8	37.7 a	9.79 U a	9.79 U
C3	6SBPP	17.5	19.7	17.5	19.7	15.3	9.29 U	15.3	11.2 U	21.8 a	11.2 U a	11.2 U
C4	7SBPP	15.8	15.8	13.8	17.8	13.8	9.53 U	15.8	9.53 U	19.7 a	9.53 U a	9.53 U
D1	8SBPP	29.7	33.0	24.8	41.3	23.1	9.41 U	23.1	9.41 U	16.5 a	9.41 U a	9.41 U
D2	9SBPP	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U a	9.57 U a	9.57 U
D3	10SBPP	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	9.96 U	18.3 a	9.96 U a	9.96 U
E1	11SBPP	20.8	22.5	17.3	20.8	10.4	9.10 U	12.1	9.10 U	17.3 a	9.10 U a	9.10 U
E2	12SBPP	9.77 U	9.77 U	9.77 U	9.77 U	9.77 U	9.77 U	9.77 U	9.79 U	9.79 U a	9.79 U a	9.79 U
E3	13SBPP	10.8	10.8	9.55 U	10.8	9.55 U	9.55 U	10.8	9.55 U	18.0 a	9.55 U a	9.55 U
E3	29SBPP	12.1	13.8	10.4	10.4	9.46 U	9.46 U	10.4	9.46 U	17.3 a	9.46 U a	9.46 U
E4	14SBPP	9.79 U	9.79 U	9.79 U	10.3	9.79 U	9.79 U	10.3	9.79 U	9.79 U a	9.79 U a	9.79 U
E4	26SBPP	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U	12.5 U a	12.5 U a	12.5 U
F1	15SBPP	10.4	11.1	9.91 U	9.91 U	9.91 U	9.91 U	9.91 U	9.91 U	12.7 a	9.91 U a	9.91 U
F1	25SBPP	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U	9.88 U a	9.88 U a	9.88 U
F2	16SBPP	11.9	11.9	10.2	11.9	9.74 U	9.74 U	10.2	9.74 U	17.1 a	9.74 U a	9.74 U
F2	28SBPP	12.5	14.3	10.8	10.8	9.96 U	9.96 U	12.5	9.96 U	17.9 a	9.96 U a	9.96 U
F3	17SBPP	9.78 U	14.5	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U	9.78 U a	9.78 U a	9.78 U
F4	18SBPP	10.4	12.1	10.4	10.4	9.86 U	9.86 U	9.86 U	9.86 U	17.3 a	9.86 U a	9.86 U
F5	19SBPP	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U a	10.0 U a	10.0 U
F5	27SBPP	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U	9.90 U a	9.90 U a	9.90 U
G1	20SBPP	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U	9.64 U a	9.64 U a	9.64 U
G2	21SBPP	16.1	17.7	12.9	14.5	12.9	9.81 U	14.5	9.81 U	16.1 a	9.81 U a	9.81 U
G3	22SBPP	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	9.81 U	17.2 a	9.81 U a	9.81 U
H1	23SBPP	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	9.57 U	14.4 a	9.57 U a	9.57 U

a Exceeds the ERL sediment screening standard
b Exceeds the PEL sediment screening standard
U Undetected. Value equals detection limit.
J Estimated. Bleow CRDL and above IDL/MDL

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Table 4
Concentrations of Organic Constituents in Sediments from Seal Beach NWR

Station Name	Sample Name	TOTALIZED VALUES Total PCB	Total LMW PAH	Total HMW PAH	Total PAH	Total DDT
A1	1SBPP	9.63 U	28.9 U	60.0 U	88.9 U	32.7 J a
B1	2SBPP	9.51 U	55.9 J	339 J	395 J	231 J a
B2	3SBPP	9.45 U	28.3 U	165 J	193 J	64.4 J a
C1	4SBPP	8.98 U	26.9 U	60.0 U	86.9 U	18.0 U a
C2	24SBPP	11.6 U	34.7 U	172 J	207 J	36.6 J a
C2	5SBPP	9.79 U	29.4 U	168 J	197 J	66.3 J a
C3	6SBPP	125 2	27.9 U	198 J	226 J	38.7 J a
C4	7SBPP	9.53 U	28.6 U	170 J	198 J	34.0 J a
D1	8SBPP	9.41 U	123 J	490 J	614 J	30.6 J a
D2	9SBPP	9.57 U	28.7 U	110 J	138 J	19.1 U a
D3	10SBPP	9.96 U	29.9 U	71.9 J	102 J	33.2 J a
E1	11SBPP	9.10 U	45.9 J	274 J	319 J	31.0 J a
E2	12SBPP	9.79 U	29.3 U	70.5 J	99.8 J	19.6 U a
E3	13SBPP	9.55 U	28.7 U	108 J	136 J	32.3 J a
E3	29SBPP	9.46 U	28.4 U	125 J	154 J	31.5 J a
E4	14SBPP	9.79 U	29.4 U	88.8 J	118 J	19.6 U a
E4	26SBPP	12.5 U	37.5 U	80.3 J	118 J	25.0 U a
F1	15SBPP	9.91 U	29.7 U	101.1 J	131 J	27.6 J a
F1	25SBPP	9.88 U	29.6 U	73.9 J	104 J	19.8 U a
F2	16SBPP	9.74 U	29.2 U	128 J	157 J	31.7 J a
F2	28SBPP	9.96 U	29.9 U	136 J	166 J	32.9 J a
F3	17SBPP	9.78 U	29.3 U	69.5 J	98.8 J	19.6 U a
F4	18SBPP	9.86 U	29.6 U	106 J	136 J	32.1 J a
F5	19SBPP	10.0 U	30.1 U	60.0 U	90.1 U	20.0 U a
F5	27SBPP	9.90 U	29.7 U	60.0 U	89.7 U	19.8 U a
G1	20SBPP	9.64 U	28.9 U	60.0 U	88.9 U	19.3 U a
G2	21SBPP	9.81 U	29.4 U	176 J	205 J	30.8 J a
G3	22SBPP	9.81 U	29.4 U	77.7 J	107 J	31.9 J a
H1	23SBPP	9.57 U	28.7 U	6.0 U	34.7 U	28.7 J a

a Exceeds the ERL sediment screening standard
b Exceeds the PEL sediment screening standard
U Undetected. Value equals detection limit.
J Estimated. Bleow CRDL and above IDL/MDL

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Conclusions

DDT metabolite concentrations exceeded PEL sediment screening standards at sample location B-1. Concentrations at other sample locations where they were detected scattered throughout the NWR were one-sixth to one-fifth of the PEL, and generally over the Effects Range Median (ERM). Three highest concentrations of DDT metabolites were at sample locations B-1, B-2, and C-2.

Pesticide concentrations in sediments in the NWR were found to be comparable to those in Los Angeles Harbor and other Southern California bays and harbors (Mearns et al., 1991). However, the sample location with the highest concentration at the NWR was the most landward sample locations in the west arm where the B-1, among highest concentrations of several metals also were found. Gradients based on dry-weight concentrations of nonpolar organic compounds can be misleading because those compounds are most likely adsorbed to organic matter in the sediment. Organic contaminant concentrations normalized to 1/kg TOC are shown in Table 5. The TOC-normalized concentration of 4,4-DDE at sample location H-1, the outermost sample location, was similar to the TOC normalized concentration at sample location B-1, among the most landward sample locations. By contrast, the gradients indicated for the TOC-normalized PAH were similar to those for the dry weight-normalized PAH, with the highest concentrations of detected compounds occurring at sample locations D-1 and C-1, respectively.

All PAH concentrations were below NOEL.

PCBs exceeded ERL sediment screening standards at sample location C-3.

Concentrations of several metals commonly exceeded the NOELs and ERLs, but were generally not more than 3 times the NOEL or 2 times possible geologic background values. No metals exceeded PEL, but were consistently highest (for chromium, copper, lead, and zinc) at sample locations A-1, B-1, and C-3. Nickel was highest at sample location A-1, B-1, and E-4.

A possible approach for evaluating whether metals are present as contaminants or as geological constituents of sediments has been proposed for other areas such as Florida (Schropp et al., 1990) and Louisiana (Pardue et al., 1992). Those authors established relationships between concentrations of heavy metals and aluminum, which is an abundant metallic component of most soils, from clean sites. They noted that the relative amounts of heavy metals to aluminum were higher than the established relationships in samples from areas influenced by human activity. This approach requires a data set from regional clean areas with a range of concentrations of aluminum and other metals that cover one or more orders of magnitude.

The NWR data do not meet that requirement, nor do we know for sure which samples might be "clean." However, the ratios of aluminum to other metals are relatively constant among

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Table 5
TOC-Normalized Concentrations of Organic Constituents on Sediment from Seal Beach NWR

Station Name	Sample Name	POLYCYCLIC AROMATIC HYDROCARBONS (All values have units of ug/kg TOC)										
		Naphthalene	Acenaphthalene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)-anthracene	Chrysene	Perylene
A1	1SBPP	408 U	408 U	408 U	408 U	408 U	408 U	408 U	408 U	408 U	408 U	408 U
B1	2SBPP	508 U	508 U	508 U	508 U	1,720	508 U	2,900	2,900	1,290	2,370	860
B2	3SBPP	1,390 U	1,390 U	1,390 U	1,390 U	1,390 U	1,390 U	2,830	3,230	1,620	2,220	3,030
C1	4SBPP	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U
C2	24SBPP	897 U	897 U	897 U	897 U	897 U	897 U	1,640	1,870	971	1,790	897 U
C2	5SBPP	1,310 U	1,310 U	1,310 U	1,310 U	1,310 U	1,310 U	3,010	3,520	1,510	3,010	1,310 U
C3	6SBPP	477 U	477 U	477 U	477 U	477 U	477 U	1,230	1,230	560	1,230	477 U
C4	7SBPP	836 U	836 U	836 U	836 U	836 U	836 U	1,560	1,730	866	1,730	836 U
D1	8SBPP	1,490 U	1,490 U	2,100	1,490 U	11,500	3,670	16,000	15,500	7,080	8,650	2,100
D2	9SBPP	698 U	698 U	698 U	698 U	698 U	698 U	1,220	1,020	698 U	814	2,040
D3	10SBPP	643 U	643 U	643 U	643 U	643 U	643 U	643 U	708	643 U	708	643 U
E1	11SBPP	1,020 U	1,020 U	1,020 U	1,020 U	1,360	1,750	4,870	5,840	2,340	3,890	1,560
E2	12SBPP	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,620	1,620	1,550 U	1,550 U	1,550 U
E3	13SBPP	955 U	955 U	955 U	955 U	955 U	955 U	1,260	1,440	955 U	1,260	955 U
E3	29SBPP	809 U	809 U	809 U	809 U	809 U	809 U	1,330	1,480	809 U	1,330	809 U
E4	14SBPP	325 U	325 U	325 U	325 U	325 U	325 U	427	512	325 U	325 U	325 U
E4	26SBPP	498 U	498 U	498 U	498 U	498 U	498 U	603	603	498 U	498 U	498 U
F1	15SBPP	1,710 U	1,710 U	1,710 U	1,710 U	1,710 U	1,710 U	2,820	2,680	1,710 U	2,190	1,710 U
F1	25SBPP	941 U	941 U	941 U	941 U	941 U	941 U	1,220	1,060	941 U	941 U	941 U
F2	16SBPP	927 U	927 U	927 U	927 U	927 U	927 U	1,630	1,630	975	1,140	927 U
F2	28SBPP	977 U	977 U	977 U	977 U	977 U	977 U	1,930	1,760	977 U	1,760	977 U
F3	17SBPP	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U
F4	18SBPP	967 U	967 U	967 U	967 U	967 U	967 U	1,190	1,360	967 U	1,190	967 U
F5	19SBPP	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U
F5	27SBPP	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U
G1	20SBPP	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U
G2	21SBPP	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	3,660	3,170	1,710	3,170	1,490 U
G3	22SBPP	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	1,570	1,830	1,490 U	1,570	1,490 U
H1	23SBPP	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U

a Exceeds the ERL sediment screening standard
U Undetected. Values are detection limits.
J Estimated. Below CRDL and above IDL/MDL.

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Table 5
TOC-Normalized Concentrations of Organic Constituents on Sediment from Seal Beach NWR

Station Name	Sample Name	POLYCYCLIC AROMATIC HYDROCARBONS (Units are ug/kg TOC)							PESTICIDES (ug/kg TOC)			
		Benzo(b)-fluoranthene	Benzo(k)-fluoranthene	Benzo(e)-pyrene	Benzo(a) pyrene	Indeno(1,2,3-cd) pyrene	Dibenzo (a,h)-anthracene	Benzo(ghi)-perylene	4,4'-DDD	4,4'-DDE	4,4'-DDT	O,P'-DDT
A1	1SBPP	408 U	408 U	408 U	408 U	408 U	408 U	408 U	408 U	774	408 U	408 U
B1	2SBPP	1,400	1,510	1,610	1,400	753	508 U	860	2,150	9,680	508 U	508 U
B2	3SBPP	1,620	1,620	4,040	1,820	1,390 U	1,390 U	1,390 U	4,040	4,040	1,390 U	1,390 U
C1	4SBPP	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U	2,360 U
C2	24SBPP	1,270	1,190	1,190	1,190	897 U	897 U	1,050	897 U	1,490 a	897 U a	897 U
C2	5SBPP	2,010	2,010	2,010	1,760	1,310 U	1,310 U	1,510	2,510	5,020	1,310 U	1,310 U
C3	6SBPP	896	1,010	896	1,010	784	477 U	784	576 U	1,120 a	576 U a	576 U
C4	7SBPP	1,380	1,380	1,210	1,560	1,210	836 U	1,380	836 U	1,730	836 U	836 U
D1	8SBPP	4,720	5,240	3,930	6,550	3,670	1,490 U	3,670	1,490 U	2,620	1,490 U	1,490 U
D2	9SBPP	698 U	698 U	698 U	698 U	698 U	698 U	698 U	698 U	698 U	698 U	698 U
D3	10SBPP	643 U	643 U	643 U	643 U	643 U	643 U	643 U	643 U	1,180	648 U	643 U
E1	11SBPP	2,340	2,530	1,950	2,340	1,170	1,020 U	1,360	1,020 U	1,950	1,020 U	1,020 U
E2	12SBPP	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U	1,550 U
E3	13SBPP	1,080	1,080	955 U	1,080	955 U	955 U	1,080	955 U	1,800	955 U	955 U
E3	29SBPP	1,030	1,180	885	885	809 U	809 U	885	809 U	1,480	809 U	809 U
E4	14SBPP	325 U	325 U	325 U	342	325 U	325 U	342	325 U	325 U	325 U	325 U
E4	26SBPP	498 U	498 U	498 U	498 U	498 U	498 U	498 U	498 U	498 U	498 U	498 U
F1	15SBPP	1,790	1,920	1,710 U	1,710 U	1,710 U	1,710 U	1,710 U	1,710 U	2,190 a	1,710 U a	1,710 U
F1	25SBPP	941 U	941 U	941 U	941 U	941 U	941 U	941 U	941 U	941 U	941 U	941 U
F2	16SBPP	1,140	1,140	975	1,140	927 U	927 U	975	927 U	1,630	927 U	927 U
F2	28SBPP	1,230	1,410	1,050	1,050	977 U	977 U	1,230	977 U	1,760	977 U	977 U
F3	17SBPP	1,320 U	1,960	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U	1,320 U
F4	18SBPP	1,020	1,190	1,020	1,020	967 U	967 U	967 U	967 U	1,700	967 U	967 U
F5	19SBPP	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U	3,710 U
F5	27SBPP	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U	4,310 U
G1	20SBPP	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U	497 U
G2	21SBPP	2,440	2,680	1,950	2,190	1,950	1,490 U	2,190	1,490 U	2,440	1,490 U	1,490 U
G3	22SBPP	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	1,490 U	2,610	1,490 U	1,490 U
H1	23SBPP	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	5,630 U	8,460	5,630 U	5,630 U

a Exceeds the ERL sediment screening standard
U Undetected. Values are detection limits.
J Estimated. Below CRDL and above IDL/MDL.

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Table 5
TOC-Normalized Concentrations of Organic Constituents on Sediment from Seal Beach NWR

Station Name	Sample Name	TOTALIZED VALUES (ug/kg TOC) Total PCB	Total LMW PAH	Total HMW PAH	Total PAH	Total DDT
A1	1SBPP	408 U	1,220 U	2,450 U	3,670 U	1,390 J a
B1	2SBPP	508 U	2,990 J	18,100 J	21,100 J	12,300 J a
B2	3SBPP	1,390 U	4,170 U	24,100 J	28,300 J	9,470 J a
C1	4SBPP	2,360 U	7,090 U	14,200 U	21,300 U	4,730 U a
C2	24SBPP	900 U	2,690 U	13,500 J	16,200 J	2,840 J a
C2	5SBPP	1,310 U	3,920 U	22,300 J	26,200 J	8,840 J a
C3	6SBPP	6,400 a	1,430 U	10,100 J	11,500 J	1,980 J a
C4	7SBPP	836 U	2,510 U	14,900 J	17,400 J	2,990 J a
D1	8SBPP	1,490 U	19,500 J	77,800 J	97,300 J	4,860 J a
D2	9SBPP	698 U	2,100 U	7,880 J	9,980 J	1,400 U a
D3	10SBPP	643 U	1,930 U	4,630 J	6,560 J	2,150 J a
E1	11SBPP	1,020 U	5,160 J	30,700 J	35,800 J	3,480 J a
E2	12SBPP	1,550 U	4,650 U	4,020 J	8,670 J	3,110 U a
E3	13SBPP	955 U	2,870 U	10,700 J	13,500 J	3,230 J a
E3	29SBPP	809 U	2,430 U	10,600 J	13,000 J	2,690 J a
E4	14SBPP	325 U	976 U	2,920 J	3,900 J	651 U a
E4	26SBPP	498 U	1,490 U	3,700 J	5,190 J	996 U a
F1	15SBPP	1,710 U	5,120 U	17,400 J	22,500 J	4,750 J a
F1	25SBPP	941 U	2,820 U	6,980 J	9,810 J	1,880 U a
F2	16SBPP	927 U	2,780 U	12,100 J	14,900 J	3,020 J a
F2	28SBPP	977 U	2,930 U	13,400 J	16,300 J	3,220 J a
F3	17SBPP	1,320 U	3,960 U	9,220 J	13,200 J	2,640 U a
F4	18SBPP	967 U	2,900 U	10,400 J	13,300 J	3,150 J a
F5	19SBPP	3,710 U	11,100 U	2,230 U	13,400 U	7,420 U a
F5	27SBPP	4,310 U	12,900 U	25,800 U	38,800 U	8,610 U a
G1	20SBPP	497 U	1,490 U	2,980 U	4,470 U	993 U a
G2	21SBPP	1,490 U	4,460 U	26,600 J	31,100 J	4,670 J a
G3	22SBPP	1,490 U	4,460 U	11,600 J	16,100 J	4,840 J a
H1	23SBPP	5,630 U	16,900 U	33,800 U	50,700 U	16,900 J a

a Exceeds the ERL sediment screening standard
U Undetected. Values are detection limits.
J Estimated. Below CRDL and above IDL/MDL.

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all of the samples from the NWR, as shown in Table 6, which suggests the possibility that variations in concentrations of metals may be due to variations in the major mineral constituents of the sediment (mainly calcium and magnesium) rather than to specific sources of metals contamination. One important qualification to that conclusion, as noted above, is the consistency with which the highest concentrations of several metals were observed at sample locations A-1, B-1, and C-3.

Based on State of California (1993) draft criteria for ranking toxic hot spots and the chemical analysis of sediments, the NWR could rank between low and moderate as a toxic hot spot. Area of potential concern for sediments is the northwest corner of the NWR, particularly at sample locations A-1, B-1, and C-3 where several metals were consistently elevated.

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Table 6
Ratios of Aluminum Content to Priority Pollutant Metals

Station Name	Sample Name	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
A1	1SB	3,070 1	146,000 U	503 1	435 1	760 2	597 2	169 2
B1	2SB	2,170 1	53,100	501 1	441 1	455 2	639 2	114 2
B2	3SB	1,980	44,600 U	551	522	344 1	676	122 1
C1	4SB	1,750	55,100 U	506	568	730	634 1	143 1
C2	24SB	1,540 1	73,500	506 1	474 1	596 1	605 2	121 2
C2	5SB	1,910 1	87,500	541 1	528 1	674 1	609 2	142 2
C3	6SB	3,280	120,000 U	528 1	457 1	733 1	725 2	121 2
C4	7SB	2,780	106,000	588 1	499 1	714 1	729 2	132 2
D1	8SB	2,350	78,700 U	653	600	762	811 1	154 1
D2	9SB	1,720 1	124,000 U	543 1	602 1	1,055 1	771 2	159 2
D3	10SB	1,330 1	83,300 U	460 1	455 1	520 1	589 1	125 2
E1	11SB	1,950	58,900 U	427	388 1	478 1	570 1	105 1
E2	12SB	1,880 1	105,000 U	524 1	631 1	892 1	750 1	162 2
E3	13SB	1,910	70,500 U	460	382 1	498 1	624 1	83 2
E3	29SB	3,280	107,000 U	702	580 1	793 1	992 1	148 2
E4	14SB	1,060 1	92,700 U	414 1	374 1	663 1	519 2	125 2
E4	26SB	1,720 1	118,000 U	567 1	473 1	916 1	744 2	149 2
F1	15SB	1,790	46,500 U	484	500	471	641	128 1
F1	25SB	2,090	53,300 U	602	630	602	873	146 1
F2	16SB	2,340	74,900 U	464	427 1	567 1	640 1	114 2
F2	28SB	2,930	87,900 U	602	520 1	706 1	850 1	126 2
F3	17SB	1,870	51,300 U	478	532	498	708	140 1
F4	18SB	1,910 1	78,300 U	438 1	430 1	597 1	614 1	131 1
F5	19SB	2,570	72,000 U	502	645	731	770 1	178 1
F5	27SB	3,570	76,800 U	653	677	742	920 1	155 1
G1	20SB	1,230 1	69,100 U	443	485 1	845	552 1	156 1
G2	21SB	1,600	36,800 U	457	374	369	598	109
G3	22SB	2,690	76,800 U	451 1	435 1	615 1	616 1	114 2
H1	23SB	2,310	34,600 U	491	596	397	672	143

1 Concentration in Table 2 exceeds the NOEL sediment screening standard (Table 1)
2 Concentration in Table 2 exceeds the ERL sediment screening standard (Table 1)
3 Concentration in Table 2 exceeds the PEL sediment screening standard (Table 1)

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REFERENCES

Katz, A., and I. R. Kaplan. 1981. Heavy Metals Behavior in Coastal Sediments of Southern California: A Critical Review and Synthesis. *Marine Chemistry.* 10:261-299.

Lindsay, W. L. 1974. *Chemical Equilibrium in Soils.* John Wiley and Sons, N.Y.

Long, E. R., and L. G. Morgan. 1990. *The Potential for Biological Effects of Sediment-Soiled Contaminants Tested in the National Status and Trends Program.* NOAA Technical Memorandum NOS OMA 52.

Mearns, A. J. et al. 1991. *Contaminant Trends in the Southern California Bight; Inventory and Assessment.* NOAA Technical Memorandum NOS ORCA 62.

Pardue, J. H., R. D. Dehune, and W. H. Patrick, Jr. 1992. Metal to Aluminum Correlation in Louisiana Coastal Wetlands; Identification of Elevated Metal Concentrations. J. Environ. Qual. 21:539-545.

Schropp, S., F. Lewis, H. Windom, J. Ryan, F. Calder, and L. Burney. 1990. Interpretation of Metal Concentrations in Estuarine Sediments of Fluoride Using Aluminum as a Reference Element,. *Estuaries* 13:227-235.

State of California. 1993. Status of the Bay Protection and Toxic Cleanup Program. Staff Report. Bay Protection and Toxic Cleanup Program, State Water Resources Control Board, Sacramento, California (November).

State of Florida. 1993. Development of an Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Florida Department of Environmental Regulation (January).

Southwest Division, National Facilities Engineering Command. 1992. Naval Weapons Station, Seal Beach, California. Installation Restoration Program. Final Wildlife Refuge Work Plan (July).

Appendix D

ENVIRONMENTAL CONTAMINANTS IN THE FOOD CHAIN

NAVAL WEAPONS STATION SEAL BEACH

Appendix D

ENVIRONMENTAL CONTAMINANTS IN THE FOOD CHAIN, NAVAL WEAPONS STATION SEAL BEACH

Prepared Harry Ohlendorf, Earl Byron, and Kathy Freas

INTRODUCTION

This study was conducted to determine whether environmental contaminants occurred in fish and invertebrates at Naval Weapons Station (NWS) Seal Beach at concentrations that could be harmful to birds feeding in the tidal saltmarsh located on the NWS Seal Beach (Navy, 1992). Most of this tidal saltmarsh is included within the Seal Beach National Wildlife Refuge (NWR), which occupies 911 acres of the 5,000-acre NWS (Figure 1; USFWS and Navy, 1990). The NWR is managed by the U.S. Fish and Wildlife Service (USFWS).

The NWR contains one of the largest remaining tidal saltmarshes in Southern California, and provides a diversity of habitats for wildlife, including several listed endangered vertebrate species, a critical nursery for many marine fish species, and significant populations of saltmarsh invertebrates that provide an abundant food supply for fish, shorebirds, waterfowl, and marine mammals.

Since establishment of the NWR, USFWS management efforts have focused on several endangered species. Two species of primary concern are the Light-footed Clapper Rail (clapper rail), *Rallus longirostris levipes*, and the California Least Tern (least tern), *Sterna antillarum browni*, which are listed as endangered by both the USFWS and the California Department of Fish and Game (CDFG).

Clapper rails are permanent residents in the saltmarsh, whereas least terns are present during the spring and summer (USFWS and Navy, 1990). Both of these species forage, nest, and rear their young in the NWR. Biological sampling was conducted during the spring, summer, and fall of 1992 and spring and summer of 1993 to evaluate contaminant concentrations in invertebrates and fish that serve as food for clapper rails and least terns. Food-chain sampling (collection of species eaten by clapper rails and least terns) was conducted because food has the greatest potential to contaminate the birds. Food-chain species chosen for sampling included the more common invertebrates and fish that had been identified as important foods of the clapper rail and the least tern, as well as benthic invertebrates that may be eaten by clapper rails and shorebirds (Atwood and Kelly, 1984; Zembal and Fancher, 1988; Navy, 1992). To the degree possible, these food-chain species were sampled during the spring and summer when the two endangered species were nesting and feeding within the saltmarsh. These sampling times were selected because they coincide with the breeding season of the clapper rail and least tern. The breeding season is the period during which exposure to contaminants is of greatest concern because adult birds consume and feed chicks food items collected in the NWR. Additionally,

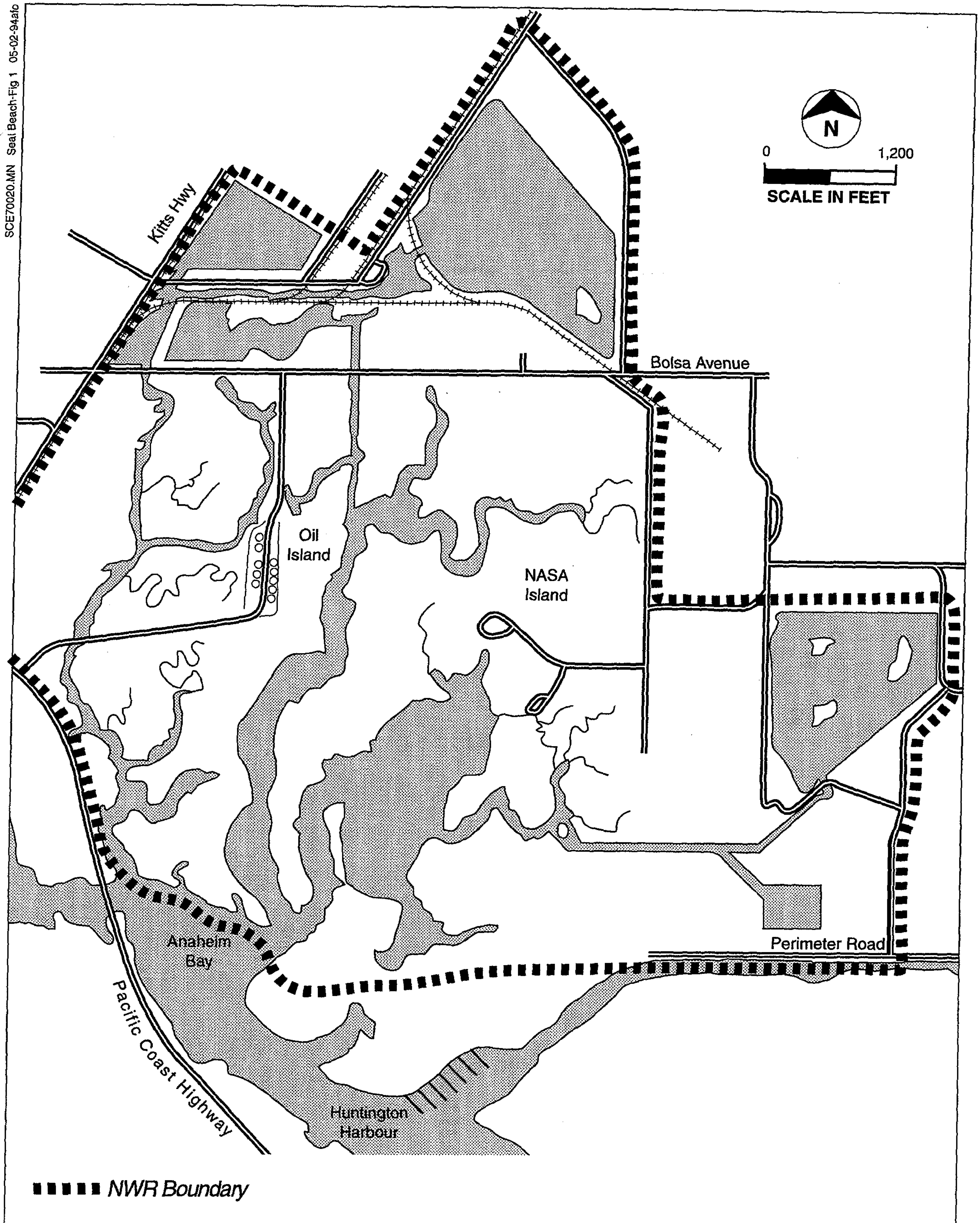

Figure 1
Seal Beach NWR Tidal Saltmarsh System

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embryos are exposed to contaminants from food consumed by adult female birds. Both embryos and chicks are more sensitive to toxic effects of contaminants than are adult birds.

Fish were to be collected three times during the least tern breeding season so that samples would reflect potential differences in contaminants in different size classes of fish. Sampling across several size classes was important because adult least terns feed their chicks increasingly larger fish as the chicks mature. No comparable temporal variability in the size of various invertebrates (which are eaten by clapper rails) was expected, so they were to be sampled once during the spring/summer season.

A phased approach was used in this study to assess current contaminant levels and their potential impacts to birds in the NWR. Sampling locations for the first phase were selected to represent a generalized exposure assessment for birds feeding in the marsh, and to determine whether contaminant gradients occur in the NWR. If areas were identified as having contaminant concentrations sufficiently elevated to cause adverse effects to birds, subsequent phases would involve sampling more intensively in those areas (to identify potential contaminant sources), or other approaches (such as comparison to regional background levels of contamination) to further assess potential impacts to the NWR's wildlife (Navy, 1992).

This Appendix reports Phase I sampling and analysis results for food-chain biota.

METHODS

Field Collection

Samples were collected by Jacobs Team biologists at 23 sample locations (Figure 2) and 4 ponds identified in the work plan (Navy, 1992). Table 1 provides a summary of sampling times and species collected during the study. Striped shore crabs, *Pachygrapsus crassipes*, saltmarsh snails, *Melampus olivaceous*, and horned snails, *Cerithidia californica*, were collected at each of the 23 sample locations. Benthic invertebrates (polychaetes and mollusks) were collected at sample locations where they were sufficiently abundant to obtain adequate biomass for analysis (minimum 15 g). Fish (primarily topsmelt, *Antherinops affinis*, and deepbody anchovy *Anchoa compressa*) were sampled in the four Port of Long Beach (POLB) mitigation ponds located within the NWR. In addition, fish were collected in NWR tidal channels where least terns were observed feeding and where it was possible to sample with the available equipment. All sampling was coordinated with the USFWS to ensure that disturbance to nesting birds (especially the clapper rails, which nest throughout the NWR) would be minimized. Fish sampling also was coordinated with investigators monitoring the POLB mitigation ponds to minimize impacts of the NWR sampling on their ongoing monitoring of biotic colonization of the ponds.

An 11-foot-long inflatable boat was used to gain access to most of the sample locations. Snails and crabs were collected by hand along the edges of tidal channels and on tidal

Table 1
Summary of Sampling Times and
Species Collected During the Seal Beach NWR Study

Species	Year and Month					
	1992			1993		
	May	June	October	May	June	July
Deepbody anchovy (*Anchoa compressa*)			X	X	X	X
Northern anchovy (*Engraulis mordax*)	X	X			X	X
California killifish (*Fundulus parvipinnis*)			X	X	X	X
Queenfish (*Seriphus politus*)			X		X	
Topsmelt (*Atherinops affinis*)	X	X	X	X	X	X
Goby (Gobiidae)				X	X	X
Diamond turbot (*Hypsopsetta guttulata*)					X	
Horned snail (*Certhidea californica*)		X	X			
Saltmarsh snail (*Melampus olivaceous*)		X	X	X	X	
Striped shore crab (*Pachygrapsus crassipes*)		X	X	X		
Clam			X			
Ghost shrimp (*Callianassa affinis*)				X	X	
Polychaete worms (*Nereis* sp.)				X		
Filamentous algae					X	

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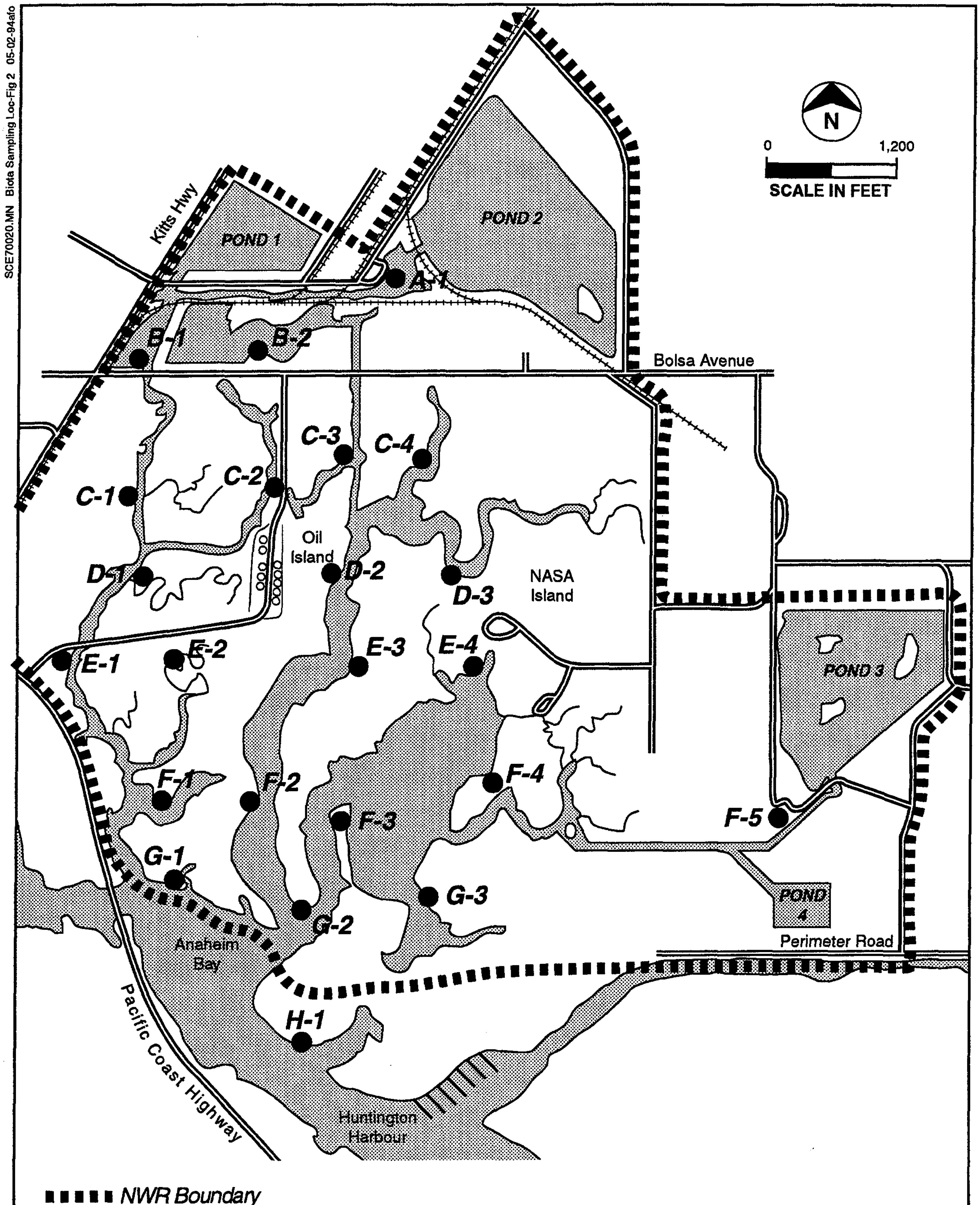

Figure 2
Sediment and Biota Sample Locations at Seal Beach NWR

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flats. They were rinsed in ambient water from the marsh before being placed into sample containers and frozen for storage. Algae or mud not removed during this rinsing remained on the samples to represent the condition of the food items as they would be ingested by foraging birds.

An air-lift dredge and screen (Pearson et al., 1973) were used at several sample locations in an attempt to collect benthic invertebrates for analysis from shallow sediment. These species occur in the top layers of sediment and are eaten by foraging shorebirds. In spite of intense efforts at several sample locations in the NWR, this technique failed to produce sufficient biomass for chemical analysis. Dr. Keith Miles, a USFWS benthic infauna specialist, was consulted to evaluate the cause for the apparent low abundance of benthic infauna in the NWR sediments. Dr. Miles found the sediments in the NWR to provide suboptimal habitat for most infauna species because of very high clay content. Under these conditions, infauna samples of sufficient biomass for analysis could be expected to be collected only in the few areas in the NWR where sediments were comparatively sandy. In consultation with the Navy and the USFWS, it was decided that the several sample locations with comparatively sandy sediments would be the focus for collection of benthic invertebrates. Polychaetes, ghost shrimp, razor clams, and other invertebrates at these sample locations were collected by digging into the top layer of sediment (6- to 12-inches deep) using hand trowels or by digging in the sediment under rocks set as channel-protection riprap.

Fish were captured with a 4-foot-deep, 100-foot-long, 1/4-inch mesh, beach seine. They were sorted by species and those with adequate biomass were rinsed with ambient water and frozen as composite samples for analysis. Individuals that were too large to be considered food items for the least terns or of species with insufficient biomass to comprise a sample for analysis were noted and returned to the pond or tidal channel.

Samples for organic contaminants analyses were placed in 250 milliliter (ml) or 500 ml chemically cleaned and certified I-Chem glass jars. Samples for inorganics analyses were placed in whirl-pak® plastic bags. Field-collected duplicate samples were taken for both inorganic and organic analyses where organisms were found in adequate abundance. Samples were stored in a freezer at the NWS pending shipment to the analytical laboratory.

USFWS conducted bioassay testing of sediments from each of the 23 sample locations using a Microtox® test, which measures toxicity to marine bacteria and is sensitive to a broad array of chemicals. When sediment samples were collected from 24 to 26 October 1992 for chemical analysis (see Appendix C), a subsample of the homogenized sediment was taken for the bioassay. This sample was stored on ice in the field and then transported to the USFWS office in Carlsbad, California, where the bioassays were conducted within 24 hours of collection.

The bioassays were conducted using the solid phase test protocol (Microbics, 1991), which is used to measure the toxicity of materials that are tightly bound to particles in soil, sediment, or sludge. The procedure allows the test organisms to come in direct contact with toxicants in an aqueous suspension of the test sample, detecting both the soluble and insoluble organic and inorganic material.

Arrangements for completion of contaminant analyses (other than Microtox®) on all samples were included in an Interagency Agreement (IAG) between the Navy and the USFWS, which included shipment of those samples to a USFWS contract laboratory. The IAG (Letter of Interagency Agreement, Contract No. N68711-92-2015) could not be completed before the 1992 field season began, so efforts to finalize that agreement proceeded as samples were collected. Samples could not be forwarded to the USFWS contract laboratory for analysis until the IAG was completed. Therefore, following their collection and before completion of the IAG, all samples were stored in a rented freezer in Building 68 at the NWS, as agreed to by all parties. On 12 August 1992, Tim Smith/Jacobs Team, discovered that power had been cut off to a portion of Building 68. The duration of the power outage is unknown, but it was sufficient for the specimens stored there to thaw and decompose. Some of the whirl-pak® containers ruptured, causing potential cross-contamination and rendering these samples unusable.

Some of the thawed but intact samples were salvaged for analysis; the others were discarded. Those salvaged (four crab samples, four horned snails, four saltmarsh snails, four topsmelt, and two anchovies) were selected to represent various areas within the NWR for comparison with results from a replacement collection. Where the organisms were available, replacement samples were collected in October 1992 and during May, June, and July 1993.

Following the discovery in August that all samples in the freezer had thawed, Jacobs Team consulted the Navy (Jeff Kidwell), USFWS (Steve Goodbred and Leonard LeCaptain), Jacobs Engineering Group Inc. (Steve Cox), and the USFWS contract laboratory (Terry Wade) to determine whether the salvaged samples would be useful for analysis and, if not, the best plan for obtaining replacement samples. The conclusions of this evaluation were that: (1) The 18 salvaged samples should be analyzed; (2) Crabs and snails should be collected to replace the lost samples (but the timing of this collection need not be constrained by the breeding season because the invertebrates are consumed year-round by clapper rails at the NWR); (3) Fish should be collected as soon as possible (because the least tern breeding season was expected to end by mid-August); and, (4) Replacement fish collection for the least tern breeding season should be scheduled for May, June, and July 1993. However, the Jacobs Team did not receive notice to proceed with the resampling until late September 1992. Thus, the resampling for invertebrates and a limited fish sampling was performed in October 1992. Invertebrate species that could not be recollected at several sample locations in October 1992 were recollected in May or June 1993. Fish were recollected in May, June, and July 1993.

Eleven samples of least tern eggs that failed to hatch in the breeding colony at NASA Island were collected by the USFWS in 1991 and 1993 were analyzed for inorganic and organic contaminants. These samples included five single eggs and six composites composed of three eggs each. After collection, the eggs were stored in a refrigerator until processing in the USFWS laboratory. Eggs were measured and then cut open with a clean scalpel around the middle. Contents were placed into I-Chem (chemically cleaned) jars and frozen. Shells were cleaned of loose debris with tap water and allowed to dry for eggshell thickness measurements (being performed by USFWS and not reported here).

Analytical Methods

Samples of invertebrates and fish were analyzed as whole-body composited samples for organic and inorganic contaminants listed in Table 2 by the Geochemical and Environmental Research Group (GERG) at Texas A&M University, College Station. These analyses were conducted through the IAG between the Navy and USFWS. The GERG is under contract to USFWS to perform analyses of biological samples for the contaminants of concern at NWS Seal Beach. The GERG was selected from among the USFWS-contracted laboratories because it was the only laboratory that could perform the full suite of analyses required. Because of the focus on the endangered species occupying the NWR, it was considered essential that samples be analyzed at a USFWS-contracted laboratory to ensure the acceptability of the data.

Method detection limits used were those specified by the USFWS and are based on NOAA Quality Assurance/Quality Control (QA/QC) criteria. Analyses for organic contaminants were conducted following the NOAA Status and Trends methods described in Appendix B of the Final Work Plan (Navy, 1992). Briefly, the samples were extracted and cleaned up before analysis by gas chromatography/mass spectrometry (GC/MS). Target detection limits were 5 nanograms per gram (ng/g) (or 0.005 milligrams per kilograms [mg/kg]) for individual Polycyclic Aromatic Hydrocarbon (PAHs) and 2 ng/g (or 0.002 mg/kg) for individual pesticides or polychlorinated biphenyls (PCBs) when levels of contamination were low; in samples with high levels of contamination the target detection limits were 60 times those values. Table 2 provides a list of detection limits achieved in the analyses. Most inorganics were analyzed by inductively coupled plasma emission spectroscopy following sample digestion. However, lead was analyzed by graphite furnace atomic absorption spectroscopy (AA) and mercury by cold vapor reduction AA. Target detection limits were as follows: 4 mg/kg lead; 3 mg/kg silver; 1 mg/kg barium; 0.6 mg/kg copper; 0.5 mg/kg arsenic, chromium, nickel, and selenium; 0.2 mg/kg zinc; and 0.1 mg/kg cadmium and mercury. Actual detection limits are listed in Table 2.

Least tern eggs were analyzed for inorganics, organochlorines, and PAHs if adequate sample biomass was available. However, the sample biomass was sometimes inadequate for several eggs, so the following analyses were performed: six composites and three single eggs were analyzed for all chemicals, and two single eggs were analyzed only for organics. Results for inorganics were expressed on dry-weight basis and organics were reported on wet-weight basis. Although wet-weight contaminant concentrations in eggs are typically adjusted to fresh wet-weight concentrations (to account for moisture loss that

Table 2
Method Detection Limits for Contaminants in Biological Samples

Sheet 1 of 4

Chemical	Method Detection Limit
Inorganics (mg/kg, dry weight)	
Aluminum	11.1
Arsenic	0.5
Barium	0.2
Boron	0.7
Cadmium	0.1
Chromium	4.0
Copper	0.8
Iron	1.4
Lead	0.5
Magnesium	12.8
Manganese	0.3
Mercury	0.1
Molybdenum	1.7
Nickel	2.6
Selenium	0.5
Silver	0.3
Strontium	0.1
Vanadium	3.6
Zinc	1.2
Organics (mg/kg, wet weight)	
Acenaphthalene	0.02
Acenaphthene	0.01 or 0.02
Acenaphthylene	0.01 or 0.02
Aldrin	0.01 or 0.02

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Table 2
Method Detection Limits for Contaminants in Biological Samples
Sheet 2 of 4

Chemical	Method Detection Limit
Anthracene	0.01 or 0.02
1,2-Benzanthracene	0.02
Benzo(a)anthracene	0.01 or 0.02
Benzo(a)pyrene	0.01 or 0.02
Benzo(b)fluoranthene	0.01 or 0.02
Benzo(e)pyrene	0.01 or 0.02
Benzo(g,h,i)perylene	0.01 or 0.02
Benzo(k)fluoranthene	0.01 or 0.02
alpha-BHC	0.01 or 0.02
beta-BHC	0.01 or 0.02
delta-BHC	0.01 or 0.02
gamma-BHC (Lindane)	0.01 or 0.02
1,1-Biphenyl	0.01 or 0.02
Biphenyl	0.02
C1-Chrysenes	0.01 or 0.02
C2-Chrysenes	0.01 or 0.02
C3-Chrysenes	0.01 or 0.02
C4-Chrysenes	0.01 or 0.02
alpha-Chlordane	0.01 or 0.02
gamma-Chlordane	0.01 or 0.02
Chrysene	0.01 or 0.02
4,4'-DDD	0.01 or 0.02
4,4'-DDE	0.01 or 0.02
4,4'-DDT	0.01 or 0.02
1,2,5,6-Dibenzanthracene	0.02
Dibenzo(a,h)anthracene	0.01 or 0.02

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Table 2
Method Detection Limits for Contaminants in Biological Samples

Sheet 3 of 4

Chemical	Method Detection Limit
C1-Dibenzothiophenes	0.01 or 0.02
C2-Dibenzothiophenes	0.01 or 0.02
C3-Dibenzothiophenes	0.01 or 0.02
Dibenzothiophene	0.01 or 0.02
Dieldrin	0.01 or 0.02
2,6-Dimethylnaphthalene	0.01 or 0.02
Endrin	0.01 or 0.02
C1-Fluoranthenes & Pyrenes	0.01 or 0.02
C1-Fluorenes	0.01 or 0.02
C2-Fluorenes	0.01 or 0.02
C3-Fluorenes	0.01 or 0.02
Fluoranthene	0.01 or 0.02
Fluorene	0.01 or 0.02
HCB	0.02
Heptachlor	0.01 or 0.02
Heptachlor Epoxide	0.01 or 0.02
Hexachlorobenzene	0.01 or 0.02
Indeno(1,2,3-CD)pyrene	0.01 or 0.02
1-Methylphenanthrene	0.01 or 0.02
1-Methylnaphthalene	0.01 or 0.02
2-Methylnaphthalene	0.01 or 0.02
Mirex	0.01 or 0.02
C1-Naphthalenes	0.01 or 0.02
C2-Naphthalenes	0.01 or 0.02
C3-Naphthalenes	0.01 or 0.02
C4-Naphthalenes	0.01 or 0.02

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Table 2
Method Detection Limits for Contaminants in Biological Samples

Sheet 4 of 4

Chemical	Method Detection Limit
Naphthalene	0.01 or 0.02
cis-Nonachlor	0.01 or 0.02
trans-Nonachlor	0.01 or 0.02
o,p'-DDD	0.01 or 0.02
o,p'-DDE	0.01 or 0.02
o,p'-DDT	0.01 or 0.02
Oxychlordane	0.01 or 0.02
C1-Phenanthrenes & Anthracenes	0.01 or 0.02
C2-Phenanthrenes & Anthracenes	0.01 or 0.02
C3-Phenanthrenes & Anthracenes	0.01 or 0.02
C4-Phenanthrenes & Anthracenes	0.01 or 0.02
PCB-1254	0.01 or 0.02
PCB-1260	0.01 or 0.02
PCB-TOTAL	0.01 or 0.02
Perylene	0.01 or 0.02
Phenanthrene	0.01 or 0.02
Pyrene	0.01 or 0.02
Toxaphene	0.01 or 0.02
1,6,7-Trimethyl-Naphthalene	0.01 or 0.02

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occurs during incubation), this was not done with samples from the NWR because of the manner in which samples were handled (e.g., compositing eggs, etc.). Nevertheless, samples from most of the eggs analyzed for organics had 70 to 77 percent moisture and 5.5 to 9.0 percent lipid, which are approximately normal levels. One sample had only 25 percent moisture and 27 percent lipid. The concentrations of organics in that egg were adjusted to approximate fresh wet-weight concentrations by dividing the reported values by 3.5, thereby reducing the concentrations to equivalent levels of moisture and lipid in other samples.

Quality assurance/quality control (QA/QC) for the chemical analyses was provided by the USFWS in accordance with that agency's existing contract with GERG. Method blanks were run with every 20 samples or with every sample set, whichever was more frequent. Blank levels were acceptable if they were no more than 3 times the method detection limit (MDL). Matrix spike/matrix spike duplicate (MS/MSD) samples were run at the same frequency as method blanks with the spiking level between 3 and 10 times the MDL. Surrogate materials were added (spiked) to each sample (including QC samples) at levels between 3 and 10 times the MDL. In addition, standard reference materials were analyzed at a frequency of one per sample batch (or 20 samples). Criteria for acceptance of analytical results are discussed in Appendix B of the work plan (Navy, 1992).

Statistical Methods

The NWR biological tissue analysis results required log transformation to normalize data distributions before statistical analysis, as is common for environmental analytical data. Means were computed (as geometric means) if detected values exceeded 50 percent of the samples. For cases where chemicals were detected in more than 50 percent, means were computed using one-half of the MDL for the "nondetected" values. This procedure is commonly used when contaminant concentrations in biological samples are not normally distributed and when the chemicals are not measurable in all samples. All means presented in this report have been back-transformed as anti-logs from the means of log values to produce the geometric means.

Contaminant concentrations in the salvaged samples were compared to the recollected samples of identical species and sampling stations for any given analyte using a series of paired t-tests.

Linear regression analysis was used to determine relationships between Microtox® toxicity results and sediment chemistry. Standard pairwise linear regression (using log-transformed values) was performed using sediment chemistry as the independent variable and toxicity as the dependent variable for each pairwise comparison. The significance of the regression coefficients was tested by F test and the strength of correlations between pairs was computed as r-squared values.

RESULTS

Chemical concentrations in invertebrate and fish tissue were originally reported by the GERG in mg/kg on a dry-weight basis for inorganic analytes and on a wet-weight basis for organic analytes. Results are reported here on those same bases. Some toxicity information is available on a wet-weight basis for inorganics or on a lipid-standardized basis for organic analytes. Using the information on average moisture and lipid content for each species given in Table 3, it is possible to convert results between dry weight, wet weight, and lipid weight standardized values to obtain approximate values based on the following formulas:

- Dry-Weight Concentration, mg/kg = (Wet Weight Concentration, mg/kg) X 100/(100-Moisture %)

- Wet-Weight Concentration, mg/kg = (Dry Weight Concentration, mg/kg/100) X (100-Moisture %)

- Lipid-Weight Concentration, mg/kg = (Wet Weight Concentration, mg/kg) / (Lipid% / 100)

Salvaged Samples

The 18 invertebrate and fish samples salvaged from the group of thawed samples that had been stored in glass jars for organic chemical analyses were analyzed for metals and organic compounds following thawing and refreezing. The results from these salvaged samples were compared with results from recollected samples of the same species from the same location (but different sampling dates) that had been kept frozen continuously before analysis, as shown in Figure 3. The results were compared statistically using paired t-tests for the most commonly detected metals and organic compounds, which included chromium, copper, lead, zinc, and DDE for all species tested. All t-tests showed no significant differences between group means, indicating that the thawed sample results could be used in combination with the other NWR study data (Figure 3). The data from the salvaged samples, combined with the other NWR study data, yielded the results discussed below.

Invertebrates

At least six species of invertebrates were collected at the NWR sample locations over the course of the study. Horned snails, saltmarsh snails, and striped shore crabs, known to be common food for the clapper rail, were common at nearly all sample locations and provided the best measure of food chain contaminant bioaccumulation throughout the NWR. The objective of the invertebrate collection was to gather samples of these three invertebrate

Table 3
Average Moisture and Lipid Content of Seal Beach NWR Invertebrates and Fish Sampled for Analysis

Species	Average Lipid (%)	Average Moisture (%)
Invertebrates		
Horned Snail	0.15	36
Saltmarsh Snail	0.51	39
Striped Shore Crab	0.66	66
Clam	0.16	61
Invertebrate Average	0.46	47
Fish		
Topsmelt	1.04	78
Deepbody Anchovy	2.74	77
Northern Anchovy	1.35	81
Goby	1.28	80
Bay Goby	1.59	79
Killifish	1.16	78
Diamond Turbot	0.73	80
Queenfish	0.63	82
Fish Average	1.61	78

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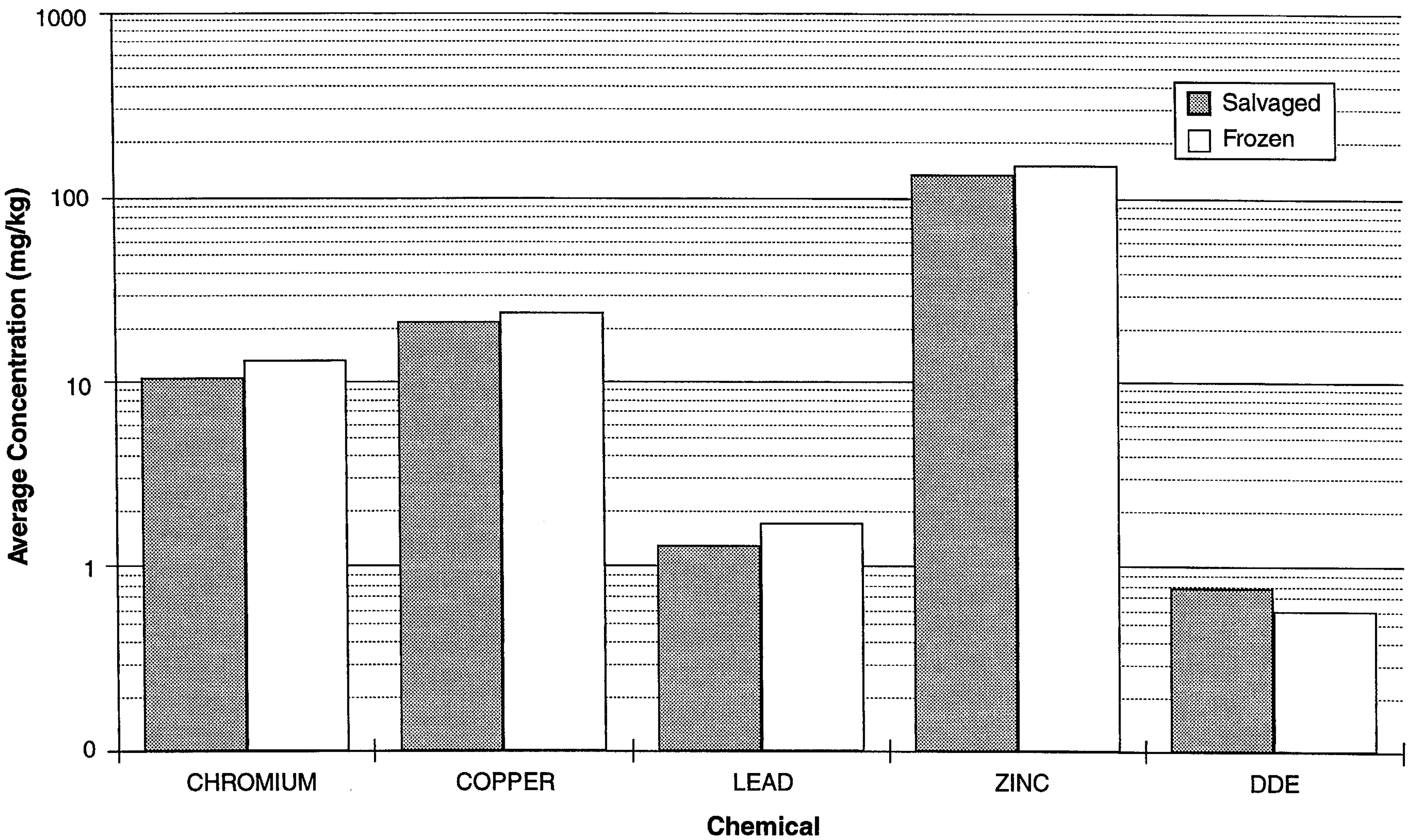

Figure 3
Comparison of Average Chemical Concentrations in Salvaged and Continuously Frozen Samples

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species from all sample locations during at least one sampling period. Invertebrate species were collected from the NWR sample locations during June and October 1992 and during May and June 1993. In addition to the common clapper rail food species, several samples of burrowing polychaete worms, razor clams, ghost shrimp, and a sample of filamentous algae were collected as examples of possible food items of shorebirds or waterfowl, thus giving a further characterization of the overall extent of contamination.

The frequency of detection and maximum concentration for each chemical across invertebrate species (and algae) are shown in Table 4. Analytical values above MDLs varied greatly with analyte. A high frequency of inorganic chemicals was detected while organic contaminants were usually not detected. Table 5 shows the geometric mean contaminant concentrations for the NWR invertebrate samples across sites. Only detected chemicals are shown.

The inorganic chemicals detected in fewer than half of the total analyses were beryllium, cadmium, mercury, molybdenum, nickel, selenium, and silver (Table 4). The highest concentrations of inorganic chemicals were often found in the least frequently collected species (Table 4). The most common, widely distributed, and easily collected food-chain species, the horned snails, usually were less contaminated than other species. The highest concentrations of cadmium, chromium, copper, lead, and nickel were found in filamentous algae, ghost shrimp, and polychaete worms. The maximum mercury value was found in a horned snail sample and the highest zinc concentration was found in saltmarsh snails. In general, these patterns were repeated in the geometric means, although many contaminants were not detected in frequencies high enough for an accurate computation of means (Table 5).

DDE in saltmarsh snails was the only organic chemical detected in more than half of the samples. Only 10 of 70 organic analytes showed any detected values in the NWR invertebrate tissue samples. The full list of organic analytes is shown in Table 2. Maximum values of individual organic contaminants were spread among horned snails, saltmarsh snails, and shore crabs (Table 4). DDD and PCBs were highest in the shore crab, while the maximum DDE concentration was found in a horned snail sample. Naphthalene, fluoranthenes, pyrenes, and 1,1 biphenyl concentrations were highest in saltmarsh snail samples.

Those species collected at all sample locations (horned snails, saltmarsh snails, shore crabs) allowed a characterization of contaminant spatial heterogeneity, although inorganic and organic maxima did not follow the same general patterns in distribution. Table 6 lists the sample locations for each of those species where the highest concentrations of eight potentially significant chemicals were found. Up to three sample locations with the highest contaminant concentrations are listed by analyte and species, and several sample locations are consistently associated with elevated heavy metal concentrations in invertebrate tissue. Sample locations with the highest values (among the top three for at least two invertebrate species) include B-1, C-1, and F-5 for cadmium, G-3 for copper, G-2 and E-4 for lead, and

Table 4
Frequency of Detection and Maximum Concentration of Contaminants in Seal Beach NWR Invertebrates and Algae

Sheet 1 of 2

Chemical[a]	Horned Snail		Saltmarsh Snail		Striped Shore Crab		Ghost Shrimp		Clam		Polychaete Worm		Filamentous Algae	
	N[b]	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.
INORGANICS (mg/kg, dry weight)														
Aluminum	27/27	963	27/27	2,610	26/26	1,850	2/2	2,400	2/2	1,900	3/3	9,200	1/1	7,020
Arsenic	25/27	1.98	26/27	2.92	25/26	7.58	2/2	13.0	2/2	5.91	3/3	29.5	1/1	3.00
Barium	27/27	4.70	22/22	13.4	18/18	12.5	1/1	5.59	--	--	--	--	1/1	24.2
Boron	27/27	13.0	22/22	10.3	18/18	15.3	1/1	18.7	--	--	--	--	1/1	67.5
Cadmium	8/27	0.15	23/27	0.76	8/26	0.23	2/2	0.66	0/2	--	3/3	0.89	0/1	--
Chromium	27/27	12.7	27/27	13.3	26/26	8.89	2/2	10.9	2/2	10.2	3/3	9.62	1/1	92.7
Copper	27/27	33.7	26/26	18.2	26/26	105	2/2	363	2/2	5.36	3/3	86.5	1/1	10.8
Iron	27/27	945	27/27	2,620	26/26	1,800	2/2	2,480	2/2	2,260	3/3	10,200	1/1	7,840
Lead	27/27	2.50	27/27	7.32	25/26	3.09	2/2	8.18	2/2	2.33	3/3	148	1/1	5.00
Magnesium	27/27	4,100	22/22	4,020	18/18	12,100	1/1	8,700	--	--	--	--	1/1	15,600
Manganese	27/27	181	27/27	155	26/26	85.8	2/2	103	2/2	144	3/3	214	1/1	147
Mercury	2/27	0.56	0/27	--	4/26	0.16	0/2	--	0/2	--	1/3	0.11	0/1	--
Molybdenum	0/27	--	0/22	--	0/18	--	0/1	--	--	--	--	--	1/1	11.5
Nickel	0/27	--	2/27	3.20	0/26	--	2/2	5.74	0/2	--	3/3	9.35	1/1	78.9
Selenium	6/27	1.07	8/27	1.14	15/26	1.30	2/2	2.53	1/2	0.88	3/3	2.97	1/1	0.50
Silver	0/27	--	20/22	0.34	9/18	0.73	--	--	--	--	--	--	0/1	--

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Table 4
Frequency of Detection and Maximum Concentration of Contaminants in Seal Beach NWR Invertebrates and Algae

Sheet 2 of 2

Chemical[a]	Horned Snail		Saltmarsh Snail		Striped Shore Crab		Ghost Shrimp		Clam		Polychaete Worm		Filamentous Algae	
	N[b]	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.
Strontium	27/27	1,050	22/22	1,330	18/18	2,130	1/1	592	--	--	--	--	1/1	79.3
Vanadium	26/27	6.52	19/22	9.42	12/18	5.34	0/1	--	--	--	--	--	1/1	18.6
Zinc	27/27	61.6	27/27	542	26/26	62.8	2/2	87.3	2/2	106	3/3	113	1/1	38.8
ORGANICS (mg/kg, wet weight)														
1,1-Biphenyl	2/27	0.03	3/23	0.03	--	--	--	--	--	--	--	--	--	--
4,4'-DDD	--	--	--	--	1/26	0.02	--	--	--	--	--	--	--	--
4,4'-DDE	4/30	0.05	18/27	0.03	9/26	0.04	--	--	1/3	0.02	--	--	--	--
C1-Pyrenes and Fluoranthenes	--	--	1/27	0.01	--	--	--	--	--	--	--	--	--	--
C1-Naphthalenes	1/27	0.02	--	--	--	--	--	--	--	--	--	--	--	--
C4-Naphthalenes	--	--	1/27	0.01	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	2/30	0.01	--	--	--	--	--	--	--	--	--	--	--	--
PCB-1254	3/28	0.02	5/27	0.27	4/26	0.58	--	--	1/3	0.07	--	--	--	--
PCB-1260	--	--	--	--	2/26	0.02	--	--	--	--	--	--	--	--
PCB-TOTAL	3/30	0.02	5/27	0.28	4/26	0.61	--	--	1/3	0.07	--	--	--	--

[a]Only those chemicals detected in these samples are listed.
[b]N = Number with detectable concentration/number of samples analyzed.

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Table 5
Geometric Mean Concentrations of Contaminants in
Seal Beach NWR Invertebrates

Sheet 1 of 2

Chemical	Species						All Species
	Horned Snail	Saltmarsh Snail	Striped Shore Crab	Ghost Shrimp	Clam	Polychaete Worms	
INORGANICS (mg/kg, dry weight)							
Aluminum	305.4	689.9	531.7	919.3	1,013	8,842	542.4
Arsenic	1.207	1.442	4.316	8.767	5.047	20.72	2.218
Barium	2.954	5.950	8.851	5.590	NC	NC	4.926
Boron	7.720	6.807	10.71	18.68	NC	NC	8.175
Cadmium	NC	0.203	NC	0.335	NC	0.584	NC
Chromium	11.65	11.41	7.000	8.288	9.767	7.874	9.732
Copper	14.81	11.46	64.71	254.6	4.867	55.24	22.91
Lead	0.979	1.930	1.171	2.477	2.169	25.51	1.466
Magnesium	1,962	2,281	10,310	8,698	NC	NC	3,219
Manganese	65.49	62.15	32.28	65.44	74.663	163.9	54.23
Mercury	NC	NC	NC	NC	NC	NC	NC
Nickel	NC	NC	NC	3.987	NC	8.726	NC
Selenium	NC	NC	0.592	2.459	NC	2.068	NC
Silver	NC	NC	NC	NC	NC	NC	NC
Strontium	946.0	1,151	1,733	591.8	NC	NC	1168
Vanadium	4.764	5.065	3.767	NC	NC	NC	4.553
Zinc	27.75	248.1	49.83	85.34	71.16	102.5	70.05

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Table 5
Geometric Mean Concentrations of Contaminants in Seal Beach NWR Invertebrates

Sheet 2 of 2

Chemical	Species						All Species
	Horned Snail	Saltmarsh Snail	Striped Shore Crab	Ghost Shrimp	Clam	Polychaete Worms	
ORGANICS (mg/kg, wet weight)							
1,1 Biphenyl	NC	NC	NC	NC	NC	NC	NC
4,4'-DDD	NC	NC	NC	NC	NC	NC	NC
4,4'-DDE	NC	0.010	NC	NC	NC	NC	NC
C1-Fluoranthenes & Pyrenes	NC	NC	NC	NC	NC	NC	NC
C1-Naphthalenes	NC	NC	NC	NC	NC	NC	NC
C4-Naphthalenes	NC	NC	NC	NC	NC	NC	NC
Hexachlorobenzene	NC	NC	NC	NC	NC	NC	NC
PCB-1254	NC	NC	NC	NC	NC	NC	NC
PCB-1260	NC	NC	NC	NC	NC	NC	NC
PCB-TOTAL	NC	NC	NC	NC	NC	NC	NC

NC = Geometric Mean not computed because detected concentration occurred in less than half the samples.

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Table 6
Biota Sampling Locations Where Highest Concentrations of Contaminants of Concern Were Found in Commonly Collected Species

	Invertebrates			Fish
Chemical[a]	Horned Snail	Saltmarsh Snail	Striped Shore Crab	Topsmelt
Cadmium	D-2	F-5	F-5	Pond 2
	G-1	A-1	B-1	F-2
	B-1	C-1	C-1	Pond 3
Chromium	D-2	G-3	D-3	Pond 3
	B-1	E-1	E-2	E-1
	F-2	A-1	E-4	B-1
Copper	C-1	F-1	H-1	Pond 3
	E-2	G-3	F-5	E-4
	D-2	E-4	G-3	B-1
Lead	G-2	G-2	E-4	Pond 3
	H-1	C-1	G-1	F-1
	B-1	E-4	F-1	Pond 4
Nickel		G-3		Pond 3
		E-4		E-1
				B-1
Zinc	D-3	F-5	C-2	F-2
	D-2	G-3	B-1	Pond 3
	E-2	B-2	F-5	E-3
DDE	B-1	A-1	B-1	Pond 1
	C-2	B-1	H-1	Pond 2
	A-1	B-2	G-2	C-4
PCBs	E-3	E-3	D-1	Pond 4
	F-1	B-2	H-1	C-4
	E-1	C-1	F-4	Pond 1

[a]For each chemical, and within each species, the locations are listed at which highest concentrations were found. Blank spaces indicate that the chemical was found at fewer than three locations. Within each species, a particular location is listed only once, even if two samples of that species from that location had among the three highest concentrations (which sometimes occurred).

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F-5 for zinc. In contrast, the highest invertebrate concentrations of DDE were found in more than one species at stations A-1 and B-1 and of PCBs at E-3 (Table 6). (See later discussion comparing observed concentrations to assessment levels.)

Fish

Overall frequency of detection and maximum concentrations for chemicals in fish are given in Table 7. Fish samples yielded detectable values and calculatable geometric means with a greater frequency than did the invertebrate samples. Geometric mean values for organic and inorganic chemicals detected in NWR fish are shown in Table 8.

The detection frequency for analytes in fish was slightly different than for invertebrate species. Inorganic chemicals detected in fewer than half of the total samples were beryllium, cadmium, mercury, molybdenum, nickel, and silver (Table 7). In contrast, the only organic analytes detected in more than half of the samples were the DDT derivatives, PCBs, phenanthrenes, and anthracenes (Tables 7 and 8). A total of only 19 out of 70 organic analytes showed values above detection limits in the NWR fish tissue samples. The full list of organic analytes is given in Table 2.

Inorganic chemicals of most interest for bioaccumulation and potential toxicity in fish tissue include cadmium, chromium, copper, lead, mercury, nickel, and zinc. With the exception of copper in killifish and mercury in deepbody anchovy, heavy metals were found in highest concentrations in topsmelt samples (Table 7). The same general pattern is shown by the geometric means (Table 8). As an exception, the high mean concentrations of chromium and mercury in diamond turbot were probably influenced by the small number of diamond turbot samples.

The inorganic chemical pattern does not hold true for organic contaminants, where high concentrations were more evenly divided between topsmelt and deepbody anchovy. In general, the highest concentrations of biphenyl, DDD, BHC, naphthalenes, and fluorenes were found in topsmelt (Table 7). However, the highest concentrations of DDT, DDE, and PCBs were found in deepbody anchovy, the species with the greatest lipid content of all fish species analyzed (Table 3).

Topsmelt were the only fish collected in sufficient distribution and abundance throughout the NWR to characterize the spatial heterogeneity of fish tissue contamination. In general, the four mitigation ponds at the landward ends of the west and east arms of the tidal saltmarsh were the areas from which samples yielded the highest contaminant concentrations. For heavy metals, Pond 3 had the greatest number of maximum concentrations (Table 6). The organochlorine compound maxima were most commonly seen in topsmelt samples from Pond 1 and sample location C-4.

Table 7
Frequency of Detection and Maximum Concentration of Contaminants in Seal Beach NWR Fish
Sheet 1 of 3

Chemical[a]	Topsmelt		Deepbody Anchovy		Northern Anchovy		Goby		Killifish		Diamond Turbot		Queenfish	
	N[b]	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.
INORGANICS (mg/kg, dry weight)														
Aluminum	33/33	3,860	9/9	1,140	6/6	800	6/6	565	5/5	1,300	2/2	439	1/1	160
Arsenic	33/33	3.52	9/9	3.67	6/6	4.43	6/6	4.68	5/5	4.14	2/2	3.05	1/1	2.50
Barium	25/25	20.1	8/8	5.69	6/6	4.61	5/5	4.97	4/4	8.81	2/2	3.19	1/1	1.82
Boron	24/24	107	7/7	100	6/6	29.4	4/4	49.1	4/4	18.4	1/2	9.13	1/1	24.3
Cadmium	3/33	0.25	2/9	0.15	0/6	--	1/6	0.16	1/5	0.12	0/2	--	0/1	--
Chromium	33/33	71.2	4/9	18.0	4/6	6.64	5/6	15.3	5/5	18.4	2/2	43.9	1/1	5.61
Copper	33/33	16.2	9/9	3.56	6/6	4.91	6/6	8.56	5/5	21.1	2/2	5.56	1/1	3.66
Iron	32/33	4,220	9/9	1,140	6/6	842	6/6	659	5/5	1,540	2/2	624	1/1	177
Lead	27/33	7.78	2/9	0.64	3/6	0.87	3/6	2.81	2/5	1.31	0/2	--	0/1	--
Magnesium	25/25	4,020	8/8	3,560	6/6	3,690	5/5	2,500	4/4	3,060	2/2	2,570	1/1	2,700
Manganese	33/33	113	9/9	29.0	6/6	26.4	6/6	55.8	5/5	73.5	2/2	59.4	1/1	22.8
Mercury	2/33	0.11	8/9	0.26	0/6	--	1/6	0.11	1/5	0.11	0/2	--	0/1	--
Molybdenum	8/24	110	3/7	100	1/6	4.80	1/4	49.1	1/4	2.60	1/1	4.80	0/1	--
Nickel	26/33	44.5	1/9	11.0	2/6	3.79	4/6	8.29	3/5	9.61	2/2	25.5	1/1	2.84
Selenium	32/33	2.44	9/9	2.40	6/6	1.40	6/6	2.71	5/5	1.49	2/2	1.88	1/1	1.04
Strontium	23/24	206	6/7	181	6/6	158	4/4	174	4/4	349	1/1	137	1/1	158
Vanadium	16/25	10.4	0/8	--	0/6	--	1/5	3.68	1/4	6.26	2/2	4.70	0/1	--
Zinc	33/33	147	9/9	117	6/6	84.0	6/6	99.0	5/5	116	2/2	97.4	1/1	75.3

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Table 7
Frequency of Detection and Maximum Concentration of Contaminants in Seal Beach NWR Fish
Sheet 2 of 3

Chemical[a]	Topsmelt		Deepbody Anchovy		Northern Anchovy		Goby		Killifish		Diamond Turbot		Queenfish	
	N[b]	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.
ORGANICS (mg/kg, wet weight)														
1,1-Biphenyl	1/10	0.02	--	--	--	--	--	--	--	--	--	--	--	--
4,4'-DDD	6/35	0.08	11/11	0.08	3/5	0.03	2/4	0.02	1/4	0.02	--	--	1/1	0.03
4,4'-DDE	35/35	0.53	11/11	1.58	5/5	0.58	4/4	0.31	4/4	0.14	1/1	0.04	1/1	0.21
o,p'-DDE	--	--	1/11	0.02	--	--	--	--	--	--	--	--	--	--
4,4'-DDT	1/35	0.02	9/11	0.04	--	--	--	--	--	--	--	--	--	--
delta-BHC	1/35	0.01	--	--	--	--	--	--	--	--	--	--	--	--
C1-Naphthalenes	2/37	0.01	--	--	--	--	--	--	--	--	--	--	--	--
C2-Naphthalenes	1/37	0.01	--	--	--	--	--	--	--	--	--	--	--	--
C3-Fluorenes	2/37	0.04	--	--	1/5	0.02	--	--	--	--	--	--	--	--
C3-Naphthalenes	1/37	0.01	1/11	0.03	--	--	--	--	--	--	--	--	--	--
C3-Phenanthrenes and Anthracenes	--	--	--	--	1/5	0.02	--	--	--	--	--	--	--	--
C4-Naphthalenes	--	--	1/11	0.03	--	--	--	--	--	--	--	--	--	--
cis-Nonachlor	1/35	0.02	3/11	0.03	--	--	--	--	--	--	--	--	--	--
trans-Nonachlor	1/35	0.02	10/11	0.04	1/5	0.01	1/4	0.02	--	--	--	--	--	--
Naphthalene	1/37	0.01	--	--	--	--	--	--	--	--	--	--	--	--
PCB-1254	19/35	0.44	10/11	0.73	4/5	0.06	3/4	0.15	3/4	0.10	1/1	0.02	1/1	0.05

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Table 7
Frequency of Detection and Maximum Concentration of Contaminants in Seal Beach NWR Fish
Sheet 3 of 3

Chemical[a]	Topsmelt		Deepbody Anchovy		Northern Anchovy		Goby		Killifish		Diamond Turbot		Queenfish	
	N[b]	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.	N	Max. Conc.
PCB-1260	1/35	0.02	--	0.02	1/5	0.02	--	--	--	--	--	--	--	--
PCB-TOTAL	11/35	0.46	10/11	0.74	4/5	0.08	3/4	0.15	3/4	0.10	1/1	0.02	1/1	0.05

[a]Only those chemicals detected in these samples are listed.
[b]N = Number with detectable concentration/number of samples analyzed.

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Table 8
Geometric Mean Concentrations of Contaminants in Seal Beach NWR Fish

Sheet 1 of 2

Chemical[a]	Species							All Species
	Topsmelt	Deepbody Anchovy	Northern Anchovy	Goby	Killifish	Diamond Turbot	Queenfish	
INORGANICS (mg/kg, dry weight)								
Aluminum	929.5	171.6	433.8	360.9	254.2	387.1	159.5	534.3
Arsenic	2.09	2.28	3.35	2.53	2.00	1.83	2.50	2.22
Barium	5.97	1.19	2.30	2.60	3.68	3.17	1.82	3.54
Boron	15.71	16.63	11.76	13.25	12.95	9.13	24.28	14.61
Cadmium	NC	NC	NC	NC	NC	NC	NC	NC
Chromium	14.01	4.10	4.45	6.75	7.87	27.55	5.61	10.10
Copper	7.64	2.71	4.56	4.35	10.34	4.45	3.66	5.91
Iron	1,021	207.5	498.0	425.7	339.7	533.5	176.7	614.0
Lead	1.19	0.26	0.36	0.64	NC	NC	NC	0.74
Magnesium	3,118	2,227	2,789	2,110	2,444	2,246	2,704	2,726
Manganese	28.15	14.64	20.86	31.96	32.52	54.67	22.75	26.03
Mercury	NC	0.16	NC	NC	NC	NC	NC	NC
Molybdenum	NC	NC	NC	NC	NC	NC	NC	NC
Nickel	9.58	NC	NC	4.54	4.47	17.61	2.84	5.10
Selenium	1.18	1.24	1.29	1.50	1.24	1.66	1.04	1.24
Strontium	114.6	51.69	76.86	46.02	273.4	137.00	158.2	97.34
Vanadium	5.96	NC	NC	NC	NC	4.22	NC	3.74
Zinc	120.3	97.82	80.00	85.18	103.3	84.45	75.30	105.3

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Table 8
Geometric Mean Concentrations of Contaminants in Seal Beach NWR Fish
Sheet 2 of 2

Chemical[a]	Species							All Species
	Topsmelt	Deepbody Anchovy	Northern Anchovy	Goby	Killifish	Diamond Turbot	Queenfish	
ORGANICS (mg/kg, wet weight)								
1,1 Biphenyl	NC	NC	NC	NC	NC	NC	NC	NC
4,4'-DDD	NC	0.05	0.01	0.02	NC	NC	0.03	0.02
4,4'-DDE	0.13	0.61	0.23	0.14	0.09	0.04	0.21	0.18
o,p'-DDE	NC	NC	NC	NC	NC	NC	NC	NC
4,4'-DDT	NC	0.02	NC	NC	NC	NC	NC	NC
BHC-delta	NC	NC	NC	NC	NC	NC	NC	NC
C1-Naphthalenes	NC	NC	NC	NC	NC	NC	NC	NC
C2-Naphthalenes	NC	NC	NC	NC	NC	NC	NC	NC
C3-Fluorenes	NC	NC	NC	NC	NC	NC	NC	NC
C3-Naphthalenes	NC	NC	NC	NC	NC	NC	NC	NC
C3-Phenanthrenes and Anthracenes	NC	NC	0.02	NC	NC	NC	NC	NC
C4-Naphthalenes	NC	NC	NC	NC	NC	NC	NC	NC
cis-Nonachlor	NC	NC	NC	NC	NC	NC	NC	NC
trans-Nonachlor	NC	0.03	NC	NC	NC	NC	NC	NC
Naphthalene	NC	NC	NC	NC	NC	NC	NC	NC
PCB-1254	0.04	0.15	0.04	0.09	0.03	0.02	0.05	0.05
PCB-1260	NC	NC	NC	NC	NC	NC	NC	NC
PCB-TOTAL	0.04	0.17	0.04	0.09	0.04	0.02	0.05	0.05

NC = Geometric Mean not computed because detected concentration occurred in less than half the samples.

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Microtox® Bioassays

Sediment with an EC_{50} (effective concentration at which the test organism's light output is decreased by 50 percent) of greater than 20,000 ppm (by sediment weight) is considered nontoxic. The closer the sample concentration is to zero, the more toxic the sediment. Using this criterion, all the tested sediments were toxic, and only those from Sample Locations C-1, G-1, and H-1 had values greater than 10,000 ppm, as shown in Table 9. Sediments from four locations (C-3, C-4, B-1, and B-2) had EC_{50} values lower than 1,000 ppm, indicating that they were the most toxic. Other stations were in the intermediate range of toxicity. Statistical comparisons (using correlations) were used to test relationships between the Microtox® bioassay results and analytical results for sediments (both of which were converted to logarithms for statistical testing because of the distribution of values). The highest correlation was between toxicity and acid volatile sulfide (R square = 0.723; Figure 4). Although there also was a significant correlation between toxicity and a few metals (zinc, copper, chromium, and nickel) or 4,4'-DDE, those relationships were much weaker than the one with sulfide, as indicated in Table 10.

Among the four metals that were statistically correlated with toxicity, molar concentrations of sulfide always exceeded the molar concentration of metals, except for that of zinc at sample locations A-1, C-1, and C-2. (When molar concentrations of sulfide exceed those of metals, the metals are probably not toxic to benthic biota.) These three sample locations were among those with intermediate or low toxicity as measured by the Microtox® bioassays.

Thus, it is likely that the bioassay results were affected most strongly by the sulfides which occur naturally in the sediment rather than the organic or inorganic contaminants of concern.

Least Tern Eggs

Concentrations of metals and organic chemicals detected in the least tern eggs are presented in Table 11. Eight inorganics were measurable in all eggs analyzed for them, whereas six other inorganics were found only in three or fewer eggs. Comparisons of geometric means for the eight inorganics between years (1991 and 1993) indicate that only manganese and strontium were different between years (t-test, $P<.05$). However, the two inorganic analytes showed opposite trends over time (Table 11).

DDE and PCBs were the only organic chemicals found at measurable levels in the eggs, and both DDE and PCB-1254 occurred at measurable levels in all eggs. Comparisons of geometric means for these two chemicals indicate that 4,4'-DDE was in higher concentration in least tern eggs in 1993 than in 1991 (t-test, $P<.05$) while other analytes indicated no differences between years.

Table 9
Ranking of EC_{50} Values for Sediments in Bioassays

Group No.[a]	Station No.	EC_{50} (ppm)
1	H-1	16,743
	C-1	13,622
	G-1	11,340
2	C-2	5,483
	D-2	5,036
	G-2	4,886
	F-1	3,832
	D-1	3,366
3	F-3	2,776
	D-3	2,295
	A-1	2,270
	E-4	2,158
	F-5	1,894
	E-1	1,851
	E-3	1,690
4	G-3	1,484
	F-2	1,282
	E-2	1,054
	F-4	1,014
5	B-2	937
	B-1	734
	C-4	468
	C-3	395

[a]Results are listed in ranked order and divided into the following subjectively defined groups (range in ppm): Group 1: 10,001-20,000; Group 2: 3,001-10,000; Group 3: 1,501-3,000; Group 4: 1,001-1,500; Group 5: 0-1,000.

Note: EC_{50} = Effective concentration at which the test organism's light output is decreased by 50 percent. (The closer the sample concentration is to zero, the more toxic the sediment, and values greater than 20,000 ppm are considered non-toxic.)

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Table 10
Relationship Between Toxicity Measured by Microtox® and Various Analytes

Analyte	R Square	Probability
Acid volatile sulfide	0.723	<0.00001
Zinc	0.394	<0.0014
Copper	0.297	<0.0072
Chromium	0.208	<0.0286
Nickel	0.172	<0.0494
Arsenic	0.022	<0.502
Lead	<0.001	>0.99
4,4'-DDE[a]	0.197	<0.0338

[a]Relationship highly dependent on a single high value for DDE.

Note: All analytes and toxicity values (EC_{50}) converted to logarithms.

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Table 11
Inorganic and Organic Chemicals Found in Least Tern Eggs Salvaged at Seal Beach NWR

Chemical	Measurable Concentrations[a]		
	N	Geometric Mean	Maximum
Inorganics (N=9)			
Aluminum	1	NC[b]	12.2
Arsenic	3	NC	0.735
Beryllium	2	NC	0.26
Boron	9	8.37	21.8
Cadmium	2	NC	0.13
Copper	9	3.09	4.76
Iron	9	133	165.
Magnesium	9	455	555.
Manganese	9	Overall = 2.23 1991 = 2.02 1993 = 2.71	3.07
Mercury	9	0.82	1.26
Molybdenum	1	NC	2.32
Selenium	3	NC	2.71
Strontium	9	Overall = 4.17 1991 = 5.11 1993 = 2.77	6.36
Zinc	9	61.5	72.8
Organics (N = 11)			
4,4'-DDE	11	Overall = 3.65 1991 = 1.96 1993 = 5.19	6.98
PCB-1254	11	(0.99)	(2.03)
PCB-1260	1	NC	(0.25)
PCB-Total	11	(1.11)	(2.28)

[a]N = Number of samples with measurable concentrations. Inorganics reported as mg/kg dry weight; organics at mg/kg wet weight. Chemicals not listed were not measurable in any samples. Values shown in parentheses were estimated on the basis of moisture and lipid levels in the eggs.
NC = Not completed because chemical was measurable in less than half the samples.

Note: Means in different years are shown only for those analytes with statistically different means between years (t-test, P<.05)

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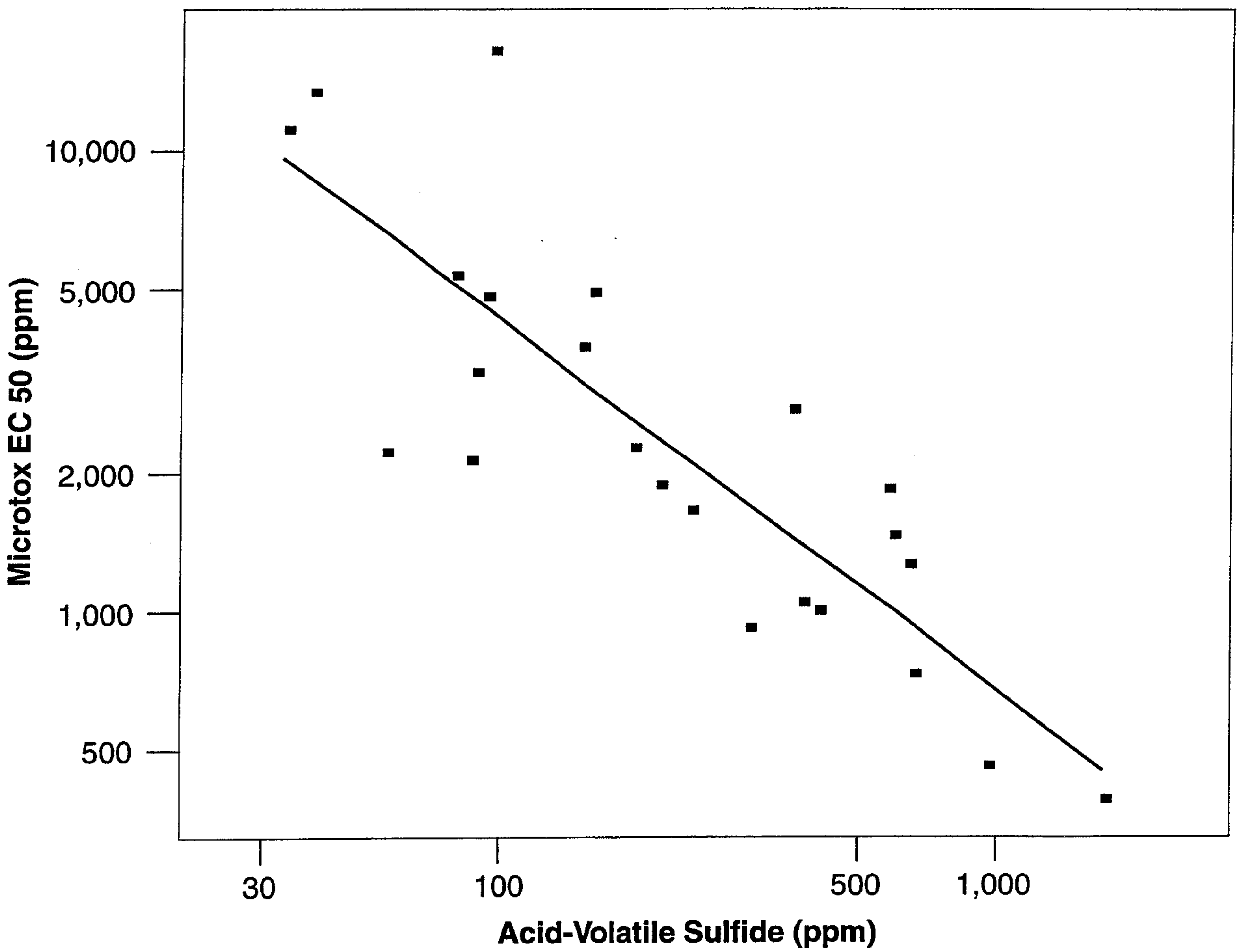

Figure 4
Relationship Between Toxicity as Measured by Microtox and Acid-volatile Sulfide in Seal Beach NWR sediment

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DISCUSSION

Chemicals of Concern

Exposure of birds to environmental contaminants can be assessed by measuring concentrations in their food, water, air, or body tissues (Ohlendorf et al., 1978; Ohlendorf, 1993). For the current study, the most directly applicable values are those for dietary exposure that are summarized in the USFWS Contaminant Hazard Reviews published by Eisler (1985 through 1993). Assessment values for inorganics available from that source, as well as those provided by Puls (1988) and the National Academy of Sciences (NAS) (NAS, 1980) are presented in Table 12. Except for cadmium, copper, and lead levels given by Puls (1988), all values from that source and all those from NAS (1980) are based on poultry.

Effect levels in wild birds for many chemicals, and especially in environmentally realistic chemical forms and concentrations, have not been clearly established. For example, Eisler (1985a) states for cadmium that "until other data become available, wildlife dietary levels exceeding 100 μg Cd/kg fresh weight on a sustained basis should be viewed with caution." However, feeding studies with mallards (*Anas platyrhyncos*) indicated that diets containing 200 mg Cd/kg produced no obvious deleterious effects after 13 weeks, although cadmium had accumulated to high levels in the ducks' kidneys. Species differences in sensitivity to various chemicals measured in the current study are unknown. Therefore, the values used for assessment of analytical results are generally the more conservative ones. The endandgered least tern and clapper rail are the species of special interest for the Wildlife Refuge Study. Assessment of the potential toxicity of contaminants of concern in the NWR has been evaluated based on collected food chain species eaten by these birds, but applies to other species with comparable diets.

Inorganic Contaminants

Aluminum. The chronic toxicity of aluminum is low (Scheuhammer, 1987), and like many of the other inorganics, its toxicity depends greatly on the chemical form found in the diet. Toxicity of aluminum also depends on the dietary levels of other elements (e.g., calcium and phosphorus) available to the birds. As noted in Table 12, the maximum tolerable level (MTL) for aluminum given by NAS (1980) is based on soluble salts of high bioavailability, but higher levels of less soluble forms found in natural substances can be tolerated. Because of its expected low toxicity to birds, aluminum is not considered a chemical of concern (COC) for clapper rails and least terns at the NWR.

Arsenic. Arsenic consistently occurred in invertebrates and fish collected in the NWR at concentrations that were much lower than the maximum dietary levels considered acceptable for birds (Tables 3, 6, and 12). Thus, arsenic is not considered a COC for clapper rails and least terns at the NWR.

Table 12
Assessment Values for Concentrations of Inorganics (mg/kg) in Bird Diets
Sheet 1 of 2

Element	Reference/Sources				
	Eisler[a] Acceptable	Puls[b]			National Academy of Sciences[c] Maximum Tolerable Level
		Normal/Adequate	High	Toxic	
Aluminum	NA	<500	NA	>1,500	200[d]
Arsenic[e]	<100 DW[f]	100[f]	NA	NA	100[f]
Barium	NA	NA	NA	NA	(20)[d]
Boron	<13 FW	NA	NA	NA	(150)
Cadmium	<0.1 FW	<5	10 - 20	>20	0.5[g]
Chromium	<10 DW	5 - 20	NA	>300	1,000
Copper	NA	10 - 50	100 - 200	>200	300
Iron	NA	80	NA	200 - 2,000	1,000
Lead	<10 DW	NA	25[h]	NA	30[g]
Magnesium	NA	600 - 3,000	3,000 - 9,000	6,400 - 12,800	(3,000)
Manganese	NA	60 - 200	1,000 - 4,000	>4,000	2,000
Mercury	<0.1 FW	<0.1	1 - 50	5 - 100	2[g]
Molybdenum	<200 DW	0.03 - 1.0	3 - 10	>200	100
Nickel	NA	0.1 - 3.0	100 - 300	700 - 1,000	300

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Table 12
Assessment Values for Concentrations of Inorganics (mg/kg) in Bird Diets
Sheet 2 of 2

Element	Reference/Sources				
	Eisler[a] Acceptable	Puls[b]			National Academy of Sciences[c] Maximum Tolerable Level
		Normal/Adequate	High	Toxic	
Selenium	<6 DW[i]	0.3 - 1.1	3 - 5	>5	2
Silver	NA	10 - 100	100	NA	100
Strontium	NA	NA	NA	>3,000	3,000
Vanadium	NA	0.1 - 3.0	6 - 50	100 - 800	10
Zinc	<178 DW	98 - 200	800 - 2,000	>2,000	1,000

[a]Eisler, 1985a, 1985b, 1986a, 1987a, 1988a, 1988b, 1989, 1990a, 1993.
[b]Puls, 1988; all values given as DW for poultry or waterfowl (when available).
[c]NAS, 1980; all values given as DW for poultry; values in parentheses were extrapolated from other species.
[d]As soluble salts of high bioavailability. Higher levels of less soluble forms found in natural substances can be tolerated.
[e]Based also on Phillips, 1990, and Stanley et al., in prep.
[f]Arsenic in organic form, which is less toxic than inorganic arsenic.
[g]Level based on human food residue considerations.
[h]Maximum no effect level for waterfowl.
[i]Based also on Ohlendorf, 1989, and USDI, 1993.

DW = Dry weight
FW = Fresh weight
NA = Not available

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Barium. Barium is similar to aluminum in that the MTL given by NAS (1980) for poultry is based on highly bioavailable soluble salts (Table 12). The maximum detected concentrations of barium in invertebrates and fish in the NWR were approximately equal to that MTL. Because this barium is probably much less bioavailable than those inorganic forms, barium is not considered a concern for clapper rails and least terns at the NWR.

Boron. Maximum concentrations of boron in algae, invertebrates, and fish were similar to the maximum dietary concentrations considered acceptable for birds (Table 12). However, these maximum detected concentrations also were similar to the geometric mean boron concentrations found in aquatic plants, invertebrates, and fish at the Volta Wildlife Area (located in the San Joaquin Valley; Schuler, 1987; Hothem and Ohlendorf, 1989), where reproductive success of aquatic birds was normal (Ohlendorf et al., 1989). Therefore, boron is not expected to cause adverse effects in clapper rails and least terns at the NWR.

Cadmium. Maximum concentrations of cadmium in invertebrates (0.5 mg/kg wet weight) were slightly higher than the dietary level of concern put forth by Eisler (1985a), but the maximum in fish was lower Cadmium does bioaccumulate in some bird tissues, based on studies with mallards, but the threshold dietary levels for adverse effects are not well known (White and Finley, 1978; White et al., 1978; Cain et al., 1983). Although cadmium at the average levels found in invertebrates probably would not adversely affect birds that consume invertebrates at the NWR, it is considered a COC because of its potential toxicity.

Chromium. Chromium concentrations in invertebrates (Table 4) and fish (Table 7) sometimes exceeded the dietary concentrations considered by Eisler (1986a) to be acceptable for birds (Table 12). The geometric mean chromium concentrations in turbot (27.5 mg/kg) and topsmelt (14.0 mg/kg), as well as all fish species combined (10.1 mg/kg) (Table 8), were at or above that level, although most were within the normal/adequate range for poultry (Puls, 1988) and all were below the MTL for poultry (NAS, 1980). Eisler (1986a) also states, "...available evidence suggests that organs and tissues of fish and wildlife that contain >4.0 mg total Cr/kg dry weight should be viewed as presumptive evidence of chromium contamination." The geometric means for chromium in horned snails (11.6 mg/kg) and saltmarsh snails (11.4 mg/kg) (Table 5) also slightly exceeded the 10 mg/kg value given by Eisler (Table 12). Thus, chromium is considered a COC for clapper rails and least terns at the NWR.

Copper. The toxicological significance of copper in diets of wild birds is not clear, but concentrations exceeding 200 or 300 mg/kg in poultry diets are considered toxic or excessive (Table 12). Maximum copper concentrations in most invertebrates and fish were in the normal/adequate range or between that and high dietary levels for poultry. However, maximum copper concentrations in crabs were within the high range and those in ghost shrimp exceeded the toxic and MTL values for poultry. Comparable values for ghost shrimp from other areas are not available, but data for seabirds indicate that copper levels in bird tissues are regulated (Furness and Rainbow, 1990) and toxicity is probably unlikely.

Therefore, direct toxicity of copper to clapper rails and least terns at the NWR is not considered to be of concern.

Iron, Magnesium, Maganese. Iron, magnesium, and manganese are essential nutrients in animal diets that have low toxicity to poultry (Table 12). Their occurrence in marine ecosystems is largely the result of natural rather than anthropogenic causes, and concentrations in bird tissues are physiologically regulated (Furness and Rainbow, 1990). Thus, they are not considered COC for clapper rails and least terns at the NWR.

Lead. Lead concentrations in polychaetes (Table 4) reached levels several times higher than those considered by Eisler (1988b) to be acceptable in bird diets, high for waterfowl diets by Puls (1988), and the MTL for poultry (Table 12). Consequently, lead is considered a COC.

Mercury. Mercury was seldom detected in biota samples, and the maximum concentration was less than 0.5 mg/kg wet weight. This low level of mercury in the NWR biota is reflected by the low concentrations found in clapper rail eggs analyzed separately by the USFWS (Schwarzbach, 1994). Mercury is not a COC at the NWR.

Molybdenum. Molybdenum was not detectable in invertebrates and the concentrations found in fish and algae were lower than those that are considered harmful for birds (Table 12). Thus, molybdenum is not considered a COC.

Nickel. Nickel concentrations in invertebrates, algae, and fish were elevated in comparison to the normal/adequate dietary range for poultry (Puls, 1988), although they were below the high range and less than the MTL (Table 12). Data available for seabirds imply that the birds do not metabolically regulate tissue concentrations of nickel (Furness and Rainbow, 1990), so it is considered a COC.

Selenium. Selenium concentrations in biological samples were below the dietary levels associated with adverse effects in wild birds (Table 12). Research on selenium effects in aquatic birds conducted by USFWS during the past 10 years suggests the concentrations in invertebrates and fish at the NWR are unlikely to affect birds at the NWR, although maximum concentrations sometimes exceed the MTL for poultry (Table 12). Consequently, selenium is not a COC for clapper rails and least terns at the NWR.

Silver. Silver was rarely detectable in biota samples and concentrations were very low in comparison to available assessment values (Table 12). Thus, it is not considered a COC at the NWR.

Strontium. Strontium occurred at maximum concentrations in biota well below the levels that are harmful to poultry (Table 12). No assessment values are available from the USFWS Contaminant Hazard Reviews (Eisler, 1985 through 1993) or from Furness and Rainbow (1990). Therefore, it is not considered a concern for clapper rails and least terns at the NWR.

Vanadium. Vanadium sometimes occurred in biota at concentrations considered high or somewhat above the MTL for poultry (Table 12). However, assessment values for vanadium in the diets of wild birds are not available. It is an essential element for marine organisms, and they have evolved mechanisms to sequester, transport, and use the vanadium to which they are exposed (Furness and Rainbow, 1990). Although the assimilative capacity of the system can be overloaded by localized excessive levels, effects are not easily demonstrated. When vanadium was fed to mallards at 100 mg/kg for 12 weeks, there was no apparent effect on their health (White and Dieter, 1978). Lipid metabolism of laying hens receiving the treated diet was altered, but their body weights were comparable to controls and they appeared healthy throughout the study. Hence, vanadium is not considered a concern for clapper rails and least terns at the NWR.

Zinc. Zinc occurred at highest concentrations (up to 542 mg/kg) in saltmarsh snails (Table 4). This concentration exceeds the normal/adequate range given by Puls (1988) and that listed by Eisler (1993) as "excessive" for poultry. All other samples had zinc concentrations in the normal/adequate range for poultry. Dietary concentrations for zinc-poisoned mallards were 2,500 to 3,000 mg/kg (Eisler, 1993), which is similar to toxic levels for poultry (Table 12). It is unknown whether the zinc concentrations found in saltmarsh snails are typical for that species elsewhere, but the concentrations in saltmarsh snails were several times higher than those in horned snails. This suggests that saltmarsh snails may naturally have higher tissue concentrations than the other sampled species. As with copper, zinc is an essential element for marine organisms and levels are likely to be closely regulated (Furness and Rainbow, 1990). Although the concentrations found in food-chain biota are probably not toxic to birds at the NWR, zinc is considered as a COC because of its possible relationship to toxicity as indicated by the Microtox® bioassay.

Organic Contaminants

Pesticides, PCBs, and PAHs. Organochlorine contaminants such as DDT and its metabolites (primarily DDE and DDD), PCBs, and chlordane have a tendency to bioaccumulate to high levels in birds that consume contaminated organisms (Stickel, 1973; Ohlendorf et al., 1978; Eisler, 1986b, 1990b). In contrast, PAHs generally show little tendency to bioaccumulate in food chains, despite their high lipid solubility, probably because most PAHs are rapidly metabolized (Eisler, 1987b). Based on the frequency of occurrence, maximum and mean concentrations, potential to bioaccumulate, and known effects of these various organics in birds, DDE is the chemical considered most likely to cause potential effects in birds at the NWR.

Dietary concentrations used for assessment of some organic contaminants also are provided by Eisler (1986b, 1990b) and by other reviews (Stickel, 1973; Ohlendorf et al., 1978), although effect levels in clapper rails and least terns are not known. In general, dietary concentrations of 3 mg/kg (fresh weight) of either DDE or PCBs are considered to cause adverse effects in birds. Dietary concentrations up to 0.3 mg/kg (fresh weight) total chlordane are considered acceptable. Acute and chronic toxicity effects on birds exposed to PAHs in their diet are very limited (Eisler, 1987b). When mallards were fed diets containing 4,000 mg PAHs/kg (mostly as naphthalenes, naphthenes, and phenanthrene) for a period of 7 months, no mortality or visible signs of toxicity were observed, but the birds did show physiological responses (including 25 percent larger livers than controls).

The USFWS has periodically determined concentrations of selected inorganic and organochlorine chemicals in freshwater fish collected from a nationwide network of stations as part of the National Contaminant Biomonitoring Program (NCBP) (Schmitt and Brumbaugh, 1990; Schmitt et al., 1990). Chemical concentrations in the NCBP are typically reported on a wet-weight basis. Average moisture content of the fish is about 75 percent; thus, wet-weight concentrations can be converted to approximate dry-weight concentrations through multiplying by a factor of 4. Results of the most recently published NCBP survey are summarized in Table 13 for comparison with results from the NWR.

Comparing the concentrations of various chemicals in fish from the NWR with those found in the NCBP (Table 13) suggests that cadmium, mercury, selenium, DDD, DDT, PCBs, cis-nonachlor, and trans-nonachlor concentrations are similar. Such a comparison also shows that copper, lead, and zinc maximum concentrations in at least some fish species from the NWR exceed the NCBP 85th percentile values and geometric means exceed the NCBP geometric means. Therefore, these three metals are potentially present at levels above background and retained as COCs. Schmitt et al. (1990) do not provide 85th percentile values for fish in the NCBP, but the geometric mean DDE concentrations in deepbody anchovy, northern anchovy, and queenfish are equal to the NCBP geometric mean or higher than that value. Although arsenic concentrations in fish from the NWR are higher than the NCBP values, this is not unexpected. Marine organisms normally contain arsenic concentrations of several to more than 100 mg/kg dry weight, but these levels present little hazard to the organism or its consumers (Eisler, 1988a).

The National Academy of Sciences (NAS) has established recommended maximum concentrations of certain toxic substances in freshwater fish tissue to protect the fish containing those chemicals, as well as to protect animals that consume the contaminated fish (NAS, 1973). These recommended guidelines are presented in Table 14. Additional criteria or standards have been published by the Food and Agriculture Organization of the United Nations (Nauen, 1983) and by the U.S. Food and Drug Administration (USFDA, 1984). However, those values are for contaminant concentrations in edible portions of fish and are not directly applicable to the (whole-body) results or purposes of this study.

Maximum detected concentrations of mercury, total chlordane, and total BHC in fish from the NWR were less than the NAS guideline levels for whole fish. Maximum concentrations of total DDT and total PCBs exceeded the recommended guidelines in Table 14.

Contaminant concentrations in fish and in mussels from California waters are measured periodically through the Toxic Substances Monitoring Program (TSMP) or the California State Mussel Watch (CSMW) (Phillips, 1988; Rasmussen, 1992). Those programs use

Table 13
Geometric Mean Concentrations (mg/kg wet weight), 85th Percentile (for Inorganics) and Maximum Concentrations Found Nationwide in Freshwater Fish by the National Contaminant Biomonitoring Program, 1984

Chemical	Geometric Mean	85th Percentile	Maximum Concentration
Inorganic[a]			
Arsenic	0.14	0.27	1.50
Cadmium	0.03	0.05	0.22
Copper	0.65	1.0	23.1
Lead	0.11	0.22	4.88
Mercury	0.10	0.17	0.37
Selenium	0.42	0.73	2.30
Zinc	21.7	34.2	118.4
Organics[b]			
4,4'-DDE	0.19	--	4.74
4,4'-DDD	0.06	--	2.55
4,4'-DDT	0.03	--	1.79
PCB 1254	0.21	--	4.0
PCB 1260	0.15	--	2.3
cis-Nonachlor	0.02	--	0.45
trans-Nonachlor	0.03	--	1.0

[a]Schmitt and Brumbaugh, 1990; average moisture content of fish was about 75% (thus, wet-weight concentrations can be converted to approximate dry-weight concentrations by multiplying by 4).
[b]Schmitt et al., 1990; only those chemicals detected in fish at Seal Beach NWR are included.

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Table 14
NAS Guideline Levels for Toxic Chemicals in Whole Fish
(mg/kg wet weight)

Chemical	NAS[a] Recommended Guideline for Freshwater Fish
Mercury	0.5
DDT (total)	1.0
PCB (total)	0.5
Chlordane (total)	0.1[b]
Benzene hexachloride (total)	0.1[b]

[a]NAS, 1973.
[b]Individually or in combination, including various isomers and component chemicals.

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"elevated data levels" (EDLs) as internal comparative measures that rank a given concentration of a particular substance with previous data from the TSMP or CSMW. The EDLs are calculated by ranking all of the results for a given chemical from the highest concentration to the lowest concentration measured (including those not detected). From this, a cumulative distribution is constructed and percentile rankings are calculated. The 85th percentile (EDL 85) is used as an indication that a chemical is elevated from the median. EDL 85 values for selected organisms and chemicals of interest in the NWR study are shown in Table 15. Although species sampled at the NWR are different from those sampled in the TSMP and CSMW, the EDL 85 values are useful for evaluating results from the NWR. Data for marine fish sampled in the TSMP are inadequate for calculation of EDL values in whole fish, but values are available for freshwater fish.

Comparing concentrations of chemicals detected in fish from the NWR with those from the TSMP indicates that concentrations of cadmium, mercury, selenium, DDE, DDD, DDT, cis-nonachlor, trans-nonachlor, BHC, and hexachlorobenzene concentrations at the NWR are not unusual (as are those for arsenic as noted above in comparison to freshwater fish in the NCBP). Concentrations of chromium, copper, lead, nickel, zinc, and PCBs in fish at the NWR appear elevated in comparing the maximum detected concentrations there with EDL 85 values from the TSMP. Values presented in Table 15 from the CSMW will be discussed later in Other Studies in comparison to results of CSMW sampling in Anaheim Bay.

In summary, the following chemicals appear to be elevated in invertebrates or fish from the NWR in comparison to various toxicological effect values or reference values:

- o Cadmium
- o Chromium
- o Copper
- o Lead
- o Nickel
- o Zinc
- o DDE
- o PCBs

These chemicals, therefore, are identified as being of concern for possible effects in clapper rails and least terns at the NWR.

Spatial Patterns

Overall patterns in the occurrence of various COCs (six inorganics, two organics) were examined by comparing the locations where they occurred at highest concentrations in the most widely collected species. Those species included horned snails, saltmarsh snails, striped shore crabs, and topsmelt. Although topsmelt were not collected at each of the 23 sample locations, they were collected at least once at nine sample locations and at least

Table 15
Elevated Data Levels (EDL 85s) for Inorganic and Organic Chemicals in the Toxic Substances Monitoring Program (TSMP) and California State Mussel Watch (CSMW)

Chemical	TSMP[a] Freshwater Fish	CSMW[b] California Mussels
Inorganics		
Aluminum	NA	662.8
Arsenic	0.48	23.82
Cadmium	0.10	10.83
Chromium	0.20	3.93
Copper	3.28	21.85
Lead	0.28	11.01
Manganese	NA	34.23
Mercury	0.07	0.44
Nickel	0.20	5.30
Selenium	1.50	4.48
Silver	0.03	0.70
Zinc	35.0	336.3
Organics		
4,4'-DDE	2,295.0	NA
4,4'-DDD	386.0	NA
4,4'-DDT	193.0	85.5
Total DDT	3,704.0	1,483.0
PCB 1254	175.0	1,420.0
PCB 1260	110.0	LT
Total PCB	281.5	1,420.0
cis-Nonachlor	20.6	NA
trans-Nonachlor	55.7	NA
Total Chlordane	171.7	192.4
delta-Benzene hexachloride	<5.0	LT
Hexachlorobenzene	7.3	0.17

[a]Rasmussen, 1992; values for inorganics are mg/kg wet weight in whole fish, those for organics μg/kg wet weight.
[b]Phillips, 1988; values are mg/kg dry weight for inorganics, μg/kg dry weight for organics.

ID = Insufficient data to calculate an EDL
LT = EDL is less than the detection limit
NA = Not available

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3 times in each of the POLB mitigation ponds, as shown in Figure 5. Topsmelt also are more mobile than are the invertebrates sampled in this study, so they may not be as reliable indicators of locations-specific exposure. Nevertheless, the evaluation did indicate that topsmelt often had highest concentrations of contaminants at the same general locations where some of the invertebrates had highest levels.

The three locations for each species where concentrations of selected contaminants were highest were listed in Table 6. The sample locations that did not show top concentrations for any inorganic chemicals (C-3, C-4, F-3, and F-4) are not located near Oil Island or other RI sites, or Huntington Harbour.

The areas that most often had among the highest concentrations of inorganics were sample locations B-1 and C-1, E-4, G-3, and the combined area of sample location F-5 and Pond 3 (Table 6). Sample location G-2 had highest concentrations of lead in both horned and saltmarsh snails. Inorganics in horned snails from sample location D-2 were often among the five highest concentrations for that species. The crabs from sample location H-1 often had among the five highest chemical concentrations for that species (Appendix B), but were among the three highest only for copper (Table 6). However, horned and saltmarsh snails from sample location H-1 were seldom found to have the highest concentrations for inorganic chemicals.

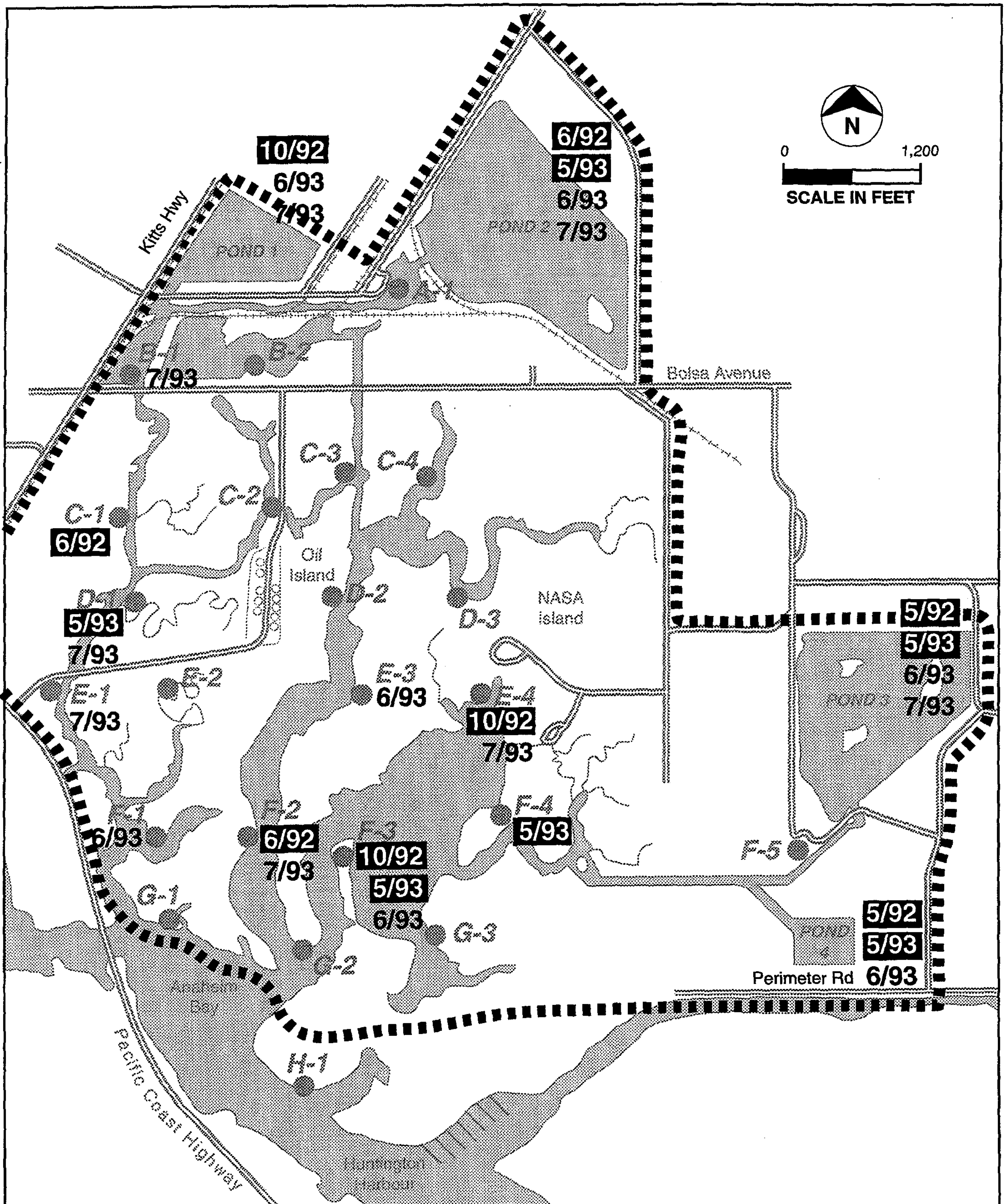
Within species, the following sample locations were areas where inorganic concentrations were generally higher:

- o Horned snails—D-2, D-3 and B-1
- o Saltmarsh snails—G-3 and E-4
- o Shore crabs—B-1, F-5, and E-4
- o Topsmelt—Pond 3

Although the highest and second-highest concentrations of inorganics within a particular species sometimes occurred at adjacent or nearby sample locations (for example, zinc in horned snails from sample locations D-2 and D-3, or lead in that species from sample locations G-2 and H-1), this was unusual. Most often the spatial patterns within species were unclear and it was more useful to consider the patterns for all invertebrate species combined with topsmelt. In doing so, concentrations for each metal appear to be generally higher at the following areas (because invertebrates and fish often were not collected at the same sample locations, ponds are combined with adjacent sample locations):

- o Cadmium—A-1 and Pond 2, B-1, C-1, F-5 and Pond 3
- o Chromium—B-1, E-1, E-4, and Pond 3
- o Copper—E-4, F-5 and Pond 3, G-3
- o Lead—E-4, F-1, G-2, Pond 3
- o Nickel—No particular pattern

SCE70020.MN Loc Topsmelt Collected 05-02-94afo



LEGEND:

5/93 Analyzed for organics; others analyzed only for inorganics

NWR Boundary

Figure 5
Locations and sampling times when topsmelt were collected, 1992 and 1993.

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- Zinc—F-5 and Pond 3 (otherwise, widely scattered sample locations)

Comparing the invertebrate patterns with those observed in the NWR sediments, the strongest similarities occur for the general area of sample location B-1 where metals such as cadmium, chromium, copper, and lead were generally elevated. However, the only statistically significant relationship by sample location between sediment and biota metals was for chromium in saltmarsh snails ($P<0.05$). Although the chromium relationship is statistically significant, only a small portion of the variation in saltmarsh snail chromium can be explained by variation in sediment chromium ($r^2=0.2$).

Among the two organic COCs, spatial patterns were more evident for DDE than for PCBs. Higher concentrations of DDE occurred in POLB Ponds 1 and 2 fish and in sample locations A-1 and B-1 invertebrates than elsewhere (Table 6). When DDE concentrations in sediments were normalized for total organic carbon concentration (a standardization for bioavailability; see Heinle draft technical memorandum), they were highest at sample locations B-1 and H-1, and significantly correlated to variation in concentrations in crabs ($P<0.01$, $r^2=0.9$).

PCBs were not detected as frequently as DDE and there were fewer similarities among species in which the highest concentrations occurred. Although both horned and saltmarsh snails from sample location E-3 had highest PCB concentrations for those species, the second highest levels for horned and saltmarsh snails and the highest concentrations for crabs and topsmelt were spatially disjunct (at F-1 and B-2, and D-1 and Pond 4, respectively). Sample location F-1 was the only other location where two species had concentrations among the five highest for two species (horned snail and saltmarsh snail). PCBs in sediments were detected only at sample location C-3, which was not among the highest sample locations for snails, crabs, or topsmelt.

Bird Eggs

Bird eggs can be good indicators of previous or current exposure of the female that laid them to some inorganics (such as mercury and selenium) and to organochlorines (Ohlendorf et al., 1978; Ohlendorf, 1993). However, for some chemicals of potential concern at the NWR (such as cadmium and lead), there is little relationship between the female's dietary exposure and the concentrations found in the eggs. Furthermore, some chemicals (including mercury and organochlorines) that are excreted into eggs may represent body burdens accumulated by the female over long periods (including exposure in previous years and in overwintering locations). Taking these various factors into consideration leads to the following conclusions:

- Inorganics for which interpretive guidelines are available generally occurred at background levels, except that of mercury, which exceeded 1 mg/kg in one egg collected during 1993.

- o DDE occurred in some eggs (especially during 1993) at levels associated with impaired reproduction in sensitive species (although effect levels in least terns are not well known).

- o Concentrations of PCBs in all eggs were less than the concentration (<16 mg/kg fresh weight) recommended by Eisler (1986b) as a proposed criterion for protection of birds.

Mercury concentrations in the least tern eggs were similar to or lower than those in Forster's tern (*Sterna forsteri*) and Caspian tern (*Sterna caspia*) eggs from San Francisco Bay (Ohlendorf et al., 1988). Lowered hatching success and a reduced fledging rate in common terns (*Sterna hirundo*) were associated with mercury concentrations between 1.0 and 3.6 mg/kg (wet weight; Connors et al., 1975), whereas herring gulls (*Larus argentatus*) were apparently not affected when eggs contained 2 to 16 mg/kg mercury (wet weight; Vermeer et al., 1973). Mallard (*Anas platyrhynchos*) reproductive success was reduced when eggs contained about 0.85 mg/kg mercury (fresh weight; Heinz, 1979).

Some species of birds, such as the brown pelican (*Pelecanus occidentalis*), are especially sensitive to adverse effects of DDE on reproductive success (Elliott and Noble, 1993). Terns appear to be intermediate among avian species in their sensitivity to DDE. More than 25 percent of eggs laid by Caspian terns breeding in San Diego Bay in 1981 failed to hatch, or died during piping (Ohlendorf et al., 1985). Although DDE residues in eggs averaged 9.3

mg/kg (wet weight) and were inversely correlated with eggshell thickness, residues were not significantly related to hatching success. In the Great Lakes, common tern populations declined during the 1970s, and there is some evidence that organochlorine contaminants were one factor that reduced reproductive success (Weseloh et al., 1989). By 1981, DDE concentrations in eggs had declined substantially and seemed no longer to be an important factor in the population dynamics of common terns on the Great Lakes. Geometric mean DDE concentrations in some colonies were 10 to 13 mg/kg (wet weight) during 1972, and they had declined to 2.5 mg/kg or less in those colonies by 1981.

The USFWS also analyzed samples of addled least tern eggs salvaged from colonies in San Francisco Bay and San Diego Bay during the mid-1980s (D.L. Roster, USFWS, personal communication). The samples from the 1980s included 43 eggs analyzed for mercury and selenium (12 samples from San Francisco Bay, 17 samples from San Diego Bay), and 42 eggs analyzed for organochlorines (13 samples from San Francisco Bay, 18 samples from San Diego Bay; as at the NWR, eggs were sometimes composited because they were small and some samples were analyzed for both inorganics and organics, but not all). Although results of those analyses have not been compared statistically to the results for NWR eggs, some general comparisons can be made.

None of the least tern eggs from San Francisco Bay had less than 1 mg/kg mercury, and concentrations ranged up to 3.2 mg/kg (D.L. Roster, USFWS, personal communication). In contrast, more of the eggs (almost half) from San Diego Bay had less than 1 mg/kg mercury, and mercury concentrations ranged up to 2.3 mg/kg. DDE concentrations in eggs from San Francisco Bay were 0.54 to 1.83 mg/kg (fresh wet weight); those from San Diego Bay were less than 2.0 mg/kg except for one egg from North Island with 1.67 mg/kg. Without more detailed verification of sample handling and the basis for reporting contaminant concentrations in the various samples, the results for least tern eggs indicate generally that mercury and DDE concentrations at the NWR are not unusual. Mercury concentrations seem comparable to those found in eggs at San Diego Bay (and lower than those found in San Francisco Bay), and DDE concentrations are more similar to those found in San Francisco Bay (although apparently higher than those found at San Diego Bay).

During 1991, the USFWS collected eight clapper rail eggs at the NWR and analyzed five of them for inorganic and three for organic contaminants (S.L. Goodbred, USFWS, personal communication). Cadmium and lead were below the detection limit (0.5mg/kg dry weight) and other metals occurred at relatively low concentrations. Although background levels for metals in clapper rail eggs are not well known, geometric means were 1.16 mg chromium/kg, 2.5 mg copper/kg, 0.07 mg mercury/kg, and 49.6 mg zinc/kg. The low range of values for mercury (<0.1 to 0.12 mg/kg) indicates that concentrations in the NWR food chain are low. By comparison, mercury concentrations in 51 California clapper rail eggs salvaged from San Francisco Bay in 1986 and 1992 averaged about 0.6 mg/kg fresh wet weight (or about 1.8 mg/kg dry weight (S.E. Schwartzbach, USFWS, personal communication). Similarly, the concentrations of DDE in clapper rail eggs from the NWR were below 1.0 mg/kg (0.31, 0.34, and 0.89 mg/kg wet weight, not corrected for moisture loss, so fresh wet-weight concentrations would be still lower).

Other organochlorines (such as trans-nonachlor and PCBs), as well as PAHs (such as pyrene and phenanthrene), occurred only at concentrations lower than 0.5 mg/kg and 0.1 mg/kg, respectively.

It appears that contaminants such as the mercury and DDE found in least tern eggs probably reflects exposure outside of the NWR. However, DDE in fish at the NWR does represent a concern for least terns feeding upon them because reproductive success could be adversely affected.

It is important to note that least tern egg samples collected from the NWR represent a biased sample of the population because all these eggs were collected when they had failed to hatch.

Other Studies

Several other studies that have been or are currently being conducted at or near the NWR provide useful information for interpreting the NWR study results. COCs from the soil, surface water, and groundwater sampling locations of Operable Units (OUs) 4, 5, 6, and 7 that border on the NWR sample locations stations are listed in Appendix C. Those OU 4 sites of concern, because of their proximity to the NWR, includes Site 5, along the Kitts Highway, and Sites 6, 23, 35, and 38 due to their proximity to POLB ponds. Slightly elevated levels of copper, lead, mercury, nickel, and zinc were detected in soils from Site 5, which is near NWR sampling locations B-1 and C-1 (Figure 6). They are listed as COCs because of the proximity of Site 5 to the NWR tidal channels. Analytical results from Sites 6, 23, 35, and 38 did not reveal COCs with regard to exposure in NWR locations (Navy, 1993).

All of the OU 5 sites are located in proximity to the NWR and could potentially contribute contaminants to the tidal saltmarsh or POLB ponds. Sites 8, 42, and 43 border the west edge of the marsh near NWR sample locations B-1 and C-1 and drain directly to the NWR. Sites 16, 44, and 45 are located near POLB Ponds 2 and 3. Site 12 is NASA Island, where the least tern colony is located near NWR sample locations D-3 and E-4 (Navy, 1994). Site 12 is unique in providing potential direct contact between the least terns and onsite contaminants. The contaminants of concern from the RI study for Sites 8, 42, and 43 (Navy, 1994) include cadmium, lead, and 1,2-DCAA in groundwater. Sites 44 and 45 had elevated levels of nickel and several organic compounds (benzene, naphthalene, phenanthrene, 2-methylnaphthalene) in groundwater. The NASA Island Site (12) contained elevated levels of antimony and thallium in groundwater. Groundwater from Site 16, near POLB Ponds 2 and 3, also contained elevated levels of antimony.

A number of sites were evaluated for OUs 6 and 7, but only Sites 4 (the oiled perimeter road) and 24 (quench water disposal area) are in proximity to the NWR and of concern for elevated contaminants. Both sites were included in the Site Investigation (SI) report (Navy, 1990). The perimeter road was found to be free of detectable levels of PCBs and hazardous levels of heavy metals, but recent samples indicated elevated lead concentrations from the road area near POLB Pond 4 and F-5 (B. Wong, unpublished data, 1994). No elevated levels of contaminants were found in the soil, surface water, or horned snail samples from Site 24.

Previous investigations at the NWS have revealed various soil and groundwater contaminants, as well as bioaccumulation in invertebrates of the tidal saltmarsh. Site 1, near the POLB Pond 2, had elevated levels of metals in the soil, with chromium of greatest concern for groundwater contamination (Navy, 1990). Site 7 contains landfill waste and is located near POLB Ponds 3 and 4 and NWR study Site F-5. Elevated contaminants in soil and groundwater include chromium, copper, and possibly mercury and zinc. Site 22, Oil Island, is entirely surrounded by the marsh and is in proximity to NWR sample locations C-2, C-3, D-2, E-2, and G-3. Previous SI results indicated elevated levels of total petroleum hydrocarbons (TPH) in soil. Chromium and mercury in horned snails collected at sites around Oil Island were elevated in comparison to State Mussel Watch data for other species of molluscs (Navy, 1990).

SCE70020.MN Biota Sampling Loc-Fig 6 05-02-94afo

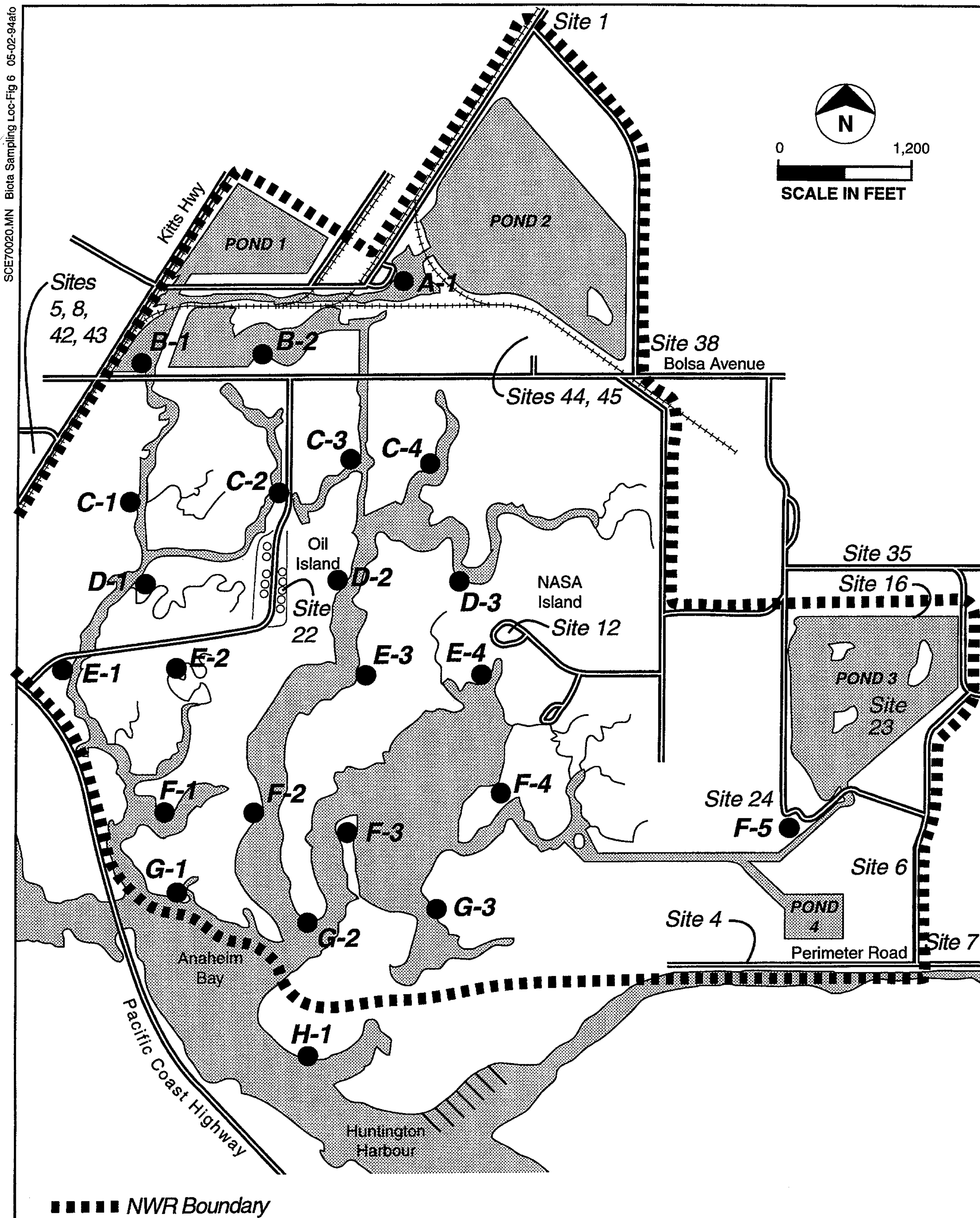

Figure 6

Locations of Installation Restoration Program Sites at Seal Beach NWR Tidal Saltmarsh System

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The POLB pond monitoring program provides a regular census of the diversity and abundance of fish and invertebrates within the four POLB ponds. Results from those studies generally confirm our fish sampling results. The Jacobs Team list of species collected (Table 1) shows fewer species than the MEC collections, primarily as a result of MEC's more diverse sampling techniques (designed to capture all size classes of fish). Our species and relative abundance estimates generally concur with the MEC monitoring data (MEC, 1992).

The National Oceanic and Atmospheric Administration (NOAA) has conducted an extensive study of temporal and spatial contaminant trends in fish and macroinvertebrates from the Southern California Bight from Point Conception to San Diego (Mearns et al., 1991). Their results are generally not applicable to the NWR study. The focus of the NOAA contaminants characterization was on edible tissue and livers rather than whole body tissues analyzed in our study. In addition, species included in the study from the NWR area were different than those collected in the NWR study. None of the species included in the NOAA study showed significant contamination for the tissues examined (Mearns et al., 1991).

The California State Mussel Watch (CSMW) monitoring results for transplanted California mussels provide a useful comparison to the NWR study as a characterization of the spatial pattern of contamination and for an assessment of the elevation of chemical concentrations over background. In addition, CSMW results provide partial data toward identifying temporal contaminant trends. However, the CSMW and NWR study species are different and, therefore, CSMW tissue chemistry results are not directly comparable to the NWR study data.

The CSMW does not show any clear temporal trends in contamination. Different stations and analytes show opposite trends for both inorganic and organic contaminants, as shown in Table 16. The only exception to this is that the highest values of several of the inorganic and organic contaminants occurred in the earlier samples (1985 and 1986). Some spatial patterns are apparent. The Bolsa Chica Channel station (CSMW 713), just outside of the NWR, shows higher concentrations of cadmium, lead, and possibly mercury in recent years (Table 16). The lack of sampling of some stations in recent years precludes an effective evaluation of Anaheim Bay spatial patterns.

Water and sediments of Huntington Harbour and Anaheim Bay, as well as in upstream drainage areas, have been examined for contaminant chemistry and toxicity in two Santa Ana Regional Water Quality Control Board (RWQCB) studies. The sampling locations in one study (Olson and Martinez, 1993; Bailey et al., 1993) do not include NWR sites, but the results are generally indicative of upstream sediment and water quality and may indicate sources of NWR contamination. A separate, ongoing RWQCB study (Reid, 1994) will include information on sediment contamination and bioaccumulation in the NWR, although results are not yet available. Copper and lead were listed as inorganic COCs for surface water runoff into the Anaheim Bay/Huntington Harbour system in the Regional Board

Table 16
California State Mussel Watch Data
for the Anaheim Bay Area

Year		1985		1986			1990-91			1991-92		
CSMW Station		710.2	713	708	710.2	713	708	708.5	713	708	708.5	713
Closest NWR Station	CSMW EDL85[a]	H1	Bolsa Chica Channel	G2	H1	Bolsa Chica Channel	G2	G2	Bolsa Chica Channel	G2	G2	Bolsa Chica Channel
INORGANICS (mg/kg, dry weight)												
Cadmium	10.83	3.88	4.74	4.92	5.70	4.95	5.70	9.30	16.00	5.40	5.70	11.00
Chromium	3.93	1.71	2.56	1.62	2.11	2.76	15.00	3.20	2.80	1.40	1.50	1.80
Copper	21.85	8.7	12.7	7.4	10.7	11.9	13.0	13.0	11.0	11.0	12.0	14.0
Lead	11.01	14.11	15.86	5.27	12.07	12.35	4.80	1.70	6.60	3.50	3.00	6.50
Mercury	0.44	0.109	0.175	0.253	0.326	0.470	0.130	0.240	0.290	0.080	0.140	0.230
Zinc	336.3	206	256	198	279	255	280	330	230	200	210	280
ORGANICS (ug/kg, wet weight)												
4,4'-DDD	NA	13.7	14.4	20.0	8.3	19.0	4.1	3.6	3.1	5.9	2.8	5.6
4,4'-DDE	NA	81.9	49.5	79.2	52.8	52.5	20.4	33.2	11.6	79.0	65.0	53.0
4,4'-DDT	NA	3.9	6.6	4.9	1.8	6.6	ND	0.9	0.9	1.6	1.6	1.7
Total DDT	NA	115.2	80.5	138.6	76.0	100.5	31.6	48.5	18.0	103.5	80.8	68.6
cis-Nonachlor	NA	ND	3.30	ND	ND	ND	0.90	1.60	1.10	1.50	1.60	1.10
trans-Nonachlor	NA	6.94	5.94	7.60	2.90	6.50	1.50	2.10	1.10	2.80	1.90	1.80
PCB 1254	NA	74.8	49.5	91.8	36.8	76.5	10.8	17.4	9.3	51.0	40.0	44.0
Total PCBs	NA	74.8	49.5	91.8	36.8	76.5	10.8	17.4	9.3	51.0	40.0	52.0

CSMW = California State Mussel Watch
NWR = Seal Beach National Wildlife Refuge
ND = Not Detected
NA = Not Available
[a]Phillips, 1988; Elevated data levels (85th percentile) for inorganic chemicals

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studies, with copper of greatest concern (Olson and Martinez, 1993). Organochlorine compounds exceeding water quality criteria included heptachlor, dieldrin, and DDT. Sediment contaminant results showed generally lower concentrations in the marsh and Anaheim Bay entrance locations than upstream in Huntington Harbour and the Huntington Harbour Warner Avenue bridge. Sediment contaminants that were elevated in upstream locations included cadmium, copper, mercury, zinc, DDE, DDT, cis-nonachlor, and trans-nonachlor (H. Smythe, Santa Ana RWQCB, unpub. data), indicating sources for these chemicals outside the NWR in the Huntington Harbour drainage. Anaheim Bay watershed samples exhibited toxicity at all sampling locations tested in the RWQCB study. Toxicity identification results indicated that non-volatile organics were most likely responsible for the acute toxicity observed in the watershed runoff samples (Bailey et al., 1993).

The evaluation of sediment erosion and deposition in the NWR tidal saltmarsh system did not indicate a clear link to the observed patterns of contamination in the marsh (see Appendix B). Although some areas of relatively high biotic contamination, such as the four POLB ponds, are areas of sediment deposition, the sites of highest bioaccumulation are evenly spread among NWR sites characterized as either deposition-prone, of high erosion potential, or as falling somewhere between those extremes (see Appendix B).

In contrast, the description of the physical characteristics of the Anaheim Bay watershed in conjunction with a knowledge of areas of deposition and erosion within the NWR may reveal offsite sources of contamination to the NWR (see Appendices A and B). State and local water, sediment, and contaminant bioaccumulation studies (discussed above) have indicated generally higher levels of contamination in the Bolsa Chica Channel and Huntington Harbour than near the mouth of Anaheim Bay. The watershed study revealed that most of the surrounding urban, upland areas, totalling over 23,000 acres, drain through the Bolsa Chica Channel to the lower end of Huntington Harbour near the eastern edge of the Anaheim Bay marsh (see Appendix A). Various inorganic and organic chemicals have been characterized as elevated in water and sediment in these upstream drainages (Olson and Martinez, 1993; Bailey et al., 1993; H. Smythe, Santa Ana RWQCB, unpublished data). It is possible that they may contribute some contaminants to the NWR from outside sources assuming that the erosional environments clustered near the mouth and main tidal channels of the NWR could act to transport contaminants to the major deposition-prone areas at the extreme inner portions of the NWR (see Appendix B). As discussed above, the patterns of bioaccumulation in the marsh do not support or refute this hypothesis. Therefore, it is not possible to use these studies to partition the degree of contamination in the NWR food chain between NWS sources and those originating outside NWS Seal Beach.

In summary, through the Navy's SI or RI/FS studies or various state contaminant assessment programs, several chemicals have been found at elevated concentrations in close proximity to or within the NWR in media that could result in exposure of biota. The COCs, as revealed by the contaminant chemistry results of other studies and confirmed by the NWR study results, are:

- o Cadmium: groundwater, potential bioaccumulation from food chain
- o Chromium: soil, groundwater, potential bioaccumulation from food chain
- o Copper: surface water, soil
- o Lead: surface water, soil, potential bioaccumulation from food chain
- o Mercury: soil
- o Nickel: groundwater, soil, potential bioaccumulation from food chain
- o Zinc: soil, possible toxicity in sediments
- o DDT: surface water, potential bioaccumulation from food chain

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Spatial Patterns

The patterns of elevated levels of contaminants in water and sediment at the NWR sometimes are reproduced in potential effect level concentrations found in invertebrate and fish tissue in several areas of the Anaheim Bay saltmarsh system. However, the spatial patterns of contamination for inorganic and organic chemicals are somewhat different and reflect different sources. In addition, some contaminants showed no consistent pattern of contamination in the biota that would relate to source areas at the NWS.

- o Metals of concern (primarily cadmium, chromium, copper, lead, and zinc) were clustered as two main areas of soil, sediment, or water contamination and bioaccumulation (in the area of NWR sample location B-1 and on the opposite side of the NWR in the POLB Pond 3 and NWR sample locations E-4, F-5, G-2, and G-3 area). Nickel showed no discernible pattern of contamination.

- o The organic contaminant DDE showed elevated bioaccumulation values in the area of POLB Ponds 1 and 2 and NWR sample locations A-1 and B-1. PCBs were generally undetected and did not demonstrate a discernible spatial pattern. Other organic compounds were not detected in high enough frequency in the biota samples to provide information on spatial patterns.

- o The RI/FS sites of greatest concern for contributing to the elevated metals concentrations in the NWR biota are Sites 1, 2, 4, 7, 8, 22, 42, and 43. DDE was not pinpointed to particular marsh locations other than in tissue samples.

Potential for Adverse Effects to Light-Footed Clapper Rails and California Least Terns

The following chemicals are of concern due to their presence in the tissues of dietary species of birds at the NWR, particularly the clapper rails and least terns:

Chemicals of Concern			
Chemical	**Reason for Concern**	**Level of Concern**	**Rationale for Level of Concern**
Cadmium	Maximum detected concentration exceeds assessment levels for invertebrates. Potentially toxic levels.	Low	Assessment value is very conservative, and ratio of highest sample location mean for invertebrates to assessment value is less than 1.0.
Chromium	Maximum detected concentration exceeds assessment levels for invertebrates and fish. Toxic levels.	Low	Ratio of maximum detected concentration to assessment value is less than 2.0, and comparisons of invertebrate and fish means to assessment values is less than 1.0.
Copper	Maximum detected concentration exceeds assessment levels for invertebrates. Potentially toxic levels.	Low	Maximum detected concentration was in ghost shrimp, which seem to have high copper levels naturally and are not primary foods of clapper rails. Mean concentrations for invertebrates at all sample locations less than 1.0.
Lead	Maximum detected concentration exceeds assessment levels for invertebrates. Potentially toxic levels. Bioaccumulates.	Low-Moderate	Maximum detected concentration in invertebrates exceeds 10, but means for all sample locations in all fish species are less than 1.0.
Nickel	Maximum detected elevated levels in invertebrates and fish. Potentially toxic levels.	Low	Although nickel concentrations were elevated in comparison to some assessment values, the maximum detected concentrations and means were less than the final assessment values.
Zinc	Maximum detected elevated exceeds assessment levels for invertebrates. Potentially toxic levels.	Low	Maximum detected concentration slightly exceeds final assessment value, but all invertebrate sample location means and fish species means are well below final assessment value.
DDE	Maximum detected concentration equals or exceeds assessment levels for invertebrates and fish. Bioaccumulates.	Moderate -High	Maximum detected concentration in invertebrates equals final assessment value, but all sample location means are less than 1.0. However, the ratios of maxiumum detected concentration for fish to final assessment value exceeds 30 and the highest fish species mean is 10 times the assessment value.

Chemicals of Concern			
Chemical	Reason for Concern	Level of Concern	Rationale for Level of Concern
PCBs	Maximum detected concentration exceeds assessment levels for invertebrates and fish. Bioaccumulates.	Low	Ratios of maximum invertebrate sample location mean and maximum fish species mean to final assessment value are less than 0.5.

Inorganic and organic contaminants are not expected to cause lethal effects on clapper rails or least terns at the concentrations found in food chain components at the NWR. Similarly, the contaminants found in least tern eggs do not indicate likely lethal effects in nesting birds. The most likely sublethal effects that could be expected (if clapper rails and least terns are similar to other species that have been tested) include eggshell thinning with reduced reproductive success in least terns, as a result of DDE found in fish:

- Chromium - Altered growth patterns and reduced survival of young

Other potential sublethal or indirect effects include the following:

- Cadmium - Retarded growth, anemia, testicular damage

- Copper - Feather loss, reduced food intake leading to weight loss or reduced weight gain and egg production

- o Lead - Highly variable effects, but possibly loss of appetite, lethargy, weakness, lesions of various organs. However, ingestion of food containing biologically incorporated lead, although contributing to the lead burden of carnivorous birds, is unlikely in itself to cause clinical lead poisoning (Eisler 1988b).

- o Nickel - Reduced growth rate (but less effect when iron and zinc are elevated)

- o Zinc - Possible effects on benthic invertebrates

- o PCBs - Possible effects in sensitive species of fish when whole-body concentrations are 0.4 mg/kg fresh weight or higher (concentrations in diet are not expected to affect birds directly.) Maximum PCB concentrations in deepbody anchovy were 0.74 mg/kg; in topsmelt they were 0.46 mg/kg. Geometric means were 0.18 and 0.066 mg/kg fresh weight.

Recommendations

No further biota sampling is needed at this time to characterize the extent of contamination in the NWR. The observed levels of invertebrate and fish contamination are not a concern for immediate remediation, but point out the need for further action. First, the sources of contamination in the NWR should be traced as part of the ongoing RI/FS investigation and the potential for NWR contamination should be considered in decisions concerning site remediation. Potential sources of contamination are Oil Island (near sample location D-2), RI Sites 5, 8, 42, and 43 (near sample location B-1), and Bolsa Chica Channel (near sample locations H-1, G-1, and G-2).

Second, indicator organisms should be monitored for evidence of further bioaccumulation of toxic chemicals that might increase the risk of exposure to endangered species. Horned snails, saltmarsh snails, and deepbody anchovy (if available) should be sampled from the two general areas of sample locations A-1, B-1 and POLB Pond 1 and sample locations F-5, G-3, and POLB Pond 3 annually and analyzed for heavy metals and organochlorine compounds as an assessment of exposure of endangered species to contaminated food organisms. These areas show consistently elevated levels of contamination and food organisms may experience further bioaccumulation as older, contaminated areas continue to erode and leach and contribute new chemicals to the ecosystem. Bioaccumulation monitoring may be proposed as part of RI/FS decisions on site remediation and/or mitigation monitoring. In addition, the POLB pond sediments should be analyzed for contaminant concentrations, as these areas are significant sediment accumulation areas exhibiting known bioaccumulation, but unknown sediment chemistry.

REFERENCES

Atwood, J. L., and P. R. Kelly. 1984. Fish Dropped on Breeding Colonies as Indicators of Least Tern Food Habits. *Wilson Bulletin* 96:34-47.

Bailey, H. C., C. DiGiorgio, and D. E. Hinton. 1993. Anaheim Bay Watershed Toxicity Study. Final Report for Testing Events 10-17 November 1992, and 16-23 February 1993. Prepared for California Regional Quality Control Board, Santa Ana Region. Department of Medicine, School of Veterinary Medicine, University of California, Davis.

Cain, B. W., L. Sileo, J. C. Franson, and J. Moore. 1983. Effects of Dietary Cadmium on Mallard Ducklings. *Environmental Research* 32:286-297.

Connors, P. G., V.C. Anderlini, R. W. Risebrough, M. Gilbertson, and H. Hays. 1975. Investigations of Heavy Metals in Common Tern Populations. *Canadian Field-Naturalist* 89:157-162.

Eisler, R. 1985a. Cadmium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service; Biological Report 85(1.2). Washington, DC.

Eisler, R. 1985b. Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service; Biological Report 85(1.5). Washington, DC.

Eisler, R. 1986a. Chromium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service; Biological Report 85(1.6). Washington, DC.

Eisler, R. 1986b. Polychlorinated Biphenyl Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service; Biological Report 85(1.7). Washington, DC.

Eisler, R. 1987a. Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service; Biological Report 85(1.10). Washington, DC.

Eisler, R. 1987b. Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service; Biological Report 85(1.11). Washington, DC.

Eisler, R. 1988a. Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service; Biological Report 85(1.12). Washington, DC.

Eisler, R. 1988b. Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service; Biological Report 85(1.14). Washington, DC.

Eisler, R. 1989. Molybdenum Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service; Biological Report 85(1.19). Washington, DC.

Eisler, R. 1990a. Boron Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service; Biological Report 85(1.20). Washington, DC.

Eisler, R. 1990b. Chlordane Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service; Biological Report 85(1.21). Washington, DC.

Eisler, R. 1993. Zinc Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service; Biological Report 10. Washington, DC.

Elliott, J. E., and D. G. Noble. 1993. Chlorinated Hydrocarbon Contaminants in Marine Birds of the Temperate North Pacific. *The Status, Ecology, and Conservation of Marine Birds of the North Pacific*. K. Vermeer, K. T. Briggs, K. H. Morgan, and D. Siegel-Causey, eds. Ottowa, Canada, Can. Wild. Serv. Spec. Publ. Pp. 241-253.

Furness, R. W., and P. S. Rainbow. 1990. *Heavy Metals in the Marine Environment*. CRC Press, Boca Raton, Florida.

Heinz, G. H. 1979. Methylmercury: Reproductive and Behavioral Effects on Three Generations of Mallard Ducks. *Journal of Wildlife Management* 43:394-401.

Hothem, R. L., and H. M. Ohlendorf. 1989. Contaminants in Foods of Aquatic Birds at Kesterson Reservoir, California, 1985. *Arch. Environ. Contam. Toxicol.* 18:773-786.

Mearns, A. J., M. Matta, G. Shigenaka, D. MacDonald, M. Buchman, H. Harris, J. Golas, and G. Lauenstein. 1991. Contaminant Trends in the Southern California Bight: Inventory and Assessment. NOAA Technical Memorandum NOS ORCA 62, Seattle, Washington. October.

MEC. 1992. Anaheim Bay Biomitigation Monitoring Project. Eighth Quarterly Report, February - April 1992. Submitted to the Port of Long Beach, Port Planning Department, Long Beach, CA. Submitted by MEC Analytical Systems, Inc., Carlsbad, California. April 15, 1992.

Microbics Corp. 1991. Microtox® Manual, Solid-Phase Test Protocol. Carlsbad, California.

NAS. See National Academy of Sciences.

National Academy of Sciences. 1980. Mineral Tolerance of Domestic Animals. Washington, DC.

National Academy of Sciences-National Academy of Engineering. 1973. Water Quality Criteria 1972 (Blue Book). EPA Ecological Research Series. EPA-R3-73-033. U.S. Environmental Protection Agency, Washington, D.C.

Nauen, C. E. 1983. Compilation of Legal Limits for Hazardous Substances in Fish and Fishery Products, Circular No. 764. FIRI/C764, Food and Agricultural Organization of the United Nations.

Navy. See Southwest Division, Naval Facilities Engineering Command.

Ohlendorf, H. M. 1989. Bioaccumulation and Effects of Selenium in Wildlife. *Selenium in Agriculture and the Environment*. L.W. Jacobs, ed., SSSA Spec. Publ. No. 23. American Society of Agronomy and Soil Science Society of America, Madison, WI. Pages 133-177.

Ohlendorf, H. M. 1993. Marine Birds and Trace Elements in the Temperature North Pacific. *The Status, Ecology, and Conservation of Marine Birds of the North Pacific*. K. Vermeer, K. T. Briggs, K. H. Morgan, and D. Siegel-Causey, eds. Ottawa, Canada: Can. Wild. Serv. Spec. Publ. Pp. 232-240.

Ohlendorf, H. M., R. L. Hothem, and D. Welsh. 1989. Nest Success, Cause-Specific Nest Failure, and Hatchability of Aquatic Birds at Selenium-Contaminated Kesterson Reservoir and a Reference Site. *Condor* 91: 787-796.

Ohlendorf, H. M., T. W. Custer, R.W. Lowe, M. Rigney, and E. Cromartie. 1988. Organochlorines and Mercury in Eggs of Coastal Terns and Herons in California, USA. *Colonial Waterbirds* 11:85-94.

Ohlendorf, H. M., R. W. Risebrough, and K. Vermeer. 1978. Exposure of Marine Birds to Environmental Pollutants. U.S. Fish and Wildlife Service, Washington, D.C. Wildlife Research Report 9.

Ohlendorf, H. M., F. C. Schaffner, T. W. Custer, and C. J. Stafford. 1985. Reproduction and Organochlorine Contaminants in Terns at San Diego Bay. *Colonial Waterbirds* 8:42-53.

Olson, T. M., and A. Martinez. 1993. Anaheim Bay Basin Update Plan Study, Draft Final Report. Prepared for California Regional Water Quality Control Board, Santa Ana Region. Department of Civil Engineering, University of California, Irvine. August.

Pearson, R. G., M. R., Litterick, and N. V. Jones. 1973. An Air-Lift for Quantitative Sampling of the Benthos. *Freshwater Biology* 3:309-315.

Phillips, D. J. H. 1990. Arsenic in Aquatic Organisms: A Review, Emphasizing Chemical Speciation. *Aquatic Toxicol*. 16:151-186.

Phillips, P. T. 1988. California State Mussel Watch Ten Year Data Summary 1977-1987. State Water Resources Control Board, Sacramento, Division of Water Quality. Water Quality Monitoring Report No. 87-3. May.

Puls, R. 1988. Mineral Levels in Animal Health, Diagnostic Data. Sherpa International, Clearbrook, B.C.

Rasmussen, D. 1992. Toxic Substances Monitoring Program, 1990 Data Report. State Water Resources Control Board, Division of Water Quality, Sacramento. Water Quality Monitoring Report 92-1WQ. May.

Reid, M. 1994. Personal communication from Mike Reid, State Water Resources Control Board, to Marjorie Castleberry, CH2M HILL. February 4.

Scheuhammer, A. M. 1987. The Chronic Toxicity of Aluminium, Cadmium, Mercury, and Lead in Birds: A Review. *Environ. Pollut.* 46:263-295.

Schmitt, C. J., and W. G. Brumbaugh. 1990. National Contaminant Biomonitoring Program: Concentrations of Arsenic, Cadmium, Copper, Lead, Mercury, Selenium, and Zinc in U.S. Freshwater Fish, 1976-1984. *Arch. Environ. Contam. Toxicol.* 19:731-747.

Schmitt, C. J., J. L. Zajicek, and P. H. Peterman. 1990. National Contaminant Biomonitoring Program: Residues of Organochlorine Chemicals in U.S. Freshwater Fish, 1976-1984. *Arch. Environ. Contam. Toxicol.* 19:748-781.

Schuler, C. A. 1987. Impacts of Agricultural Drainwater and Contaminants on Wetlands at Kesterson Reservoir, California. Master of Science Thesis, Oregon State University, Corvallis. June.

Schwarzbach, S. E. 1994. Personal communication from Steve Schwarzbach, USFWS to Harry M. Ohlendorf, CH2M HILL. February 3.

Southwest Division, Naval Facilities Engineering Command. 1994. *Naval Weapons Station Seal Beach, Installation Restoration Program, Operable Unit 5 Site Inspection Report*, Preliminary Draft. 13 January.

Southwest Division, Naval Facilities Engineering Command. 1993. *Naval Weapons Station Seal Beach, Installation Restoration Program, Draft Operable Unit 4 Site Inspection Report.* 28 October.

Southwest Division, Naval Facilities Engineering Command. 1992. *Naval Weapons Station Seal Beach, California. Installation Restoration Program, Final Wildlife Refuge Study Work Plan.* 23 July.

Southwest Division, Naval Facilities Engineering Command. 1990. *Final Site Inspection Report. Volume I - Technical Report, Naval Weapons Station Seal Beach, California.* October.

Stanley, T. R., Jr., J. W. Spann, G. J. Smith, and R. Rosscoe. Manuscript in Preparation. Main and Interactive Effects of Arsenic and Selenium on Mallard Reproduction and Growth and Survival of Ducklings. U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD.

Stickel, L. F. 1973. Pesticide Residues in Birds and Mammals. In *Environmental Pollution by Pesticides*, C.A. Edwards, ed. Plenum Press, New York, NY. Pp. 254-312.

USDI. See U.S. Department of the Interior.

U.S. Department of the Interior. 1993. Personal communication from RaJean Strube Fossen, Bureau of Reclamation, to Harry M. Ohlendorf, CH2M HILL. July 12.

USFDA. See U.S. Food and Drug Administration.

U.S. Food and Drug Administration, Bureau of Foods. 1985. Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed. USFDA, Washington, D.C.

USFWS. See U.S. Fish and Wildlife Service.

USFWS and Navy. See U.S. Fish and Wildlife Service with U.S. Navy.

U.S. Fish and Wildlife Service. 1990. *Patuxent Analytical Control Facility Reference Manual.* U.S. Fish and Wildlife Service, Laurel, Maryland. June.

U.S. Fish and Wildlife Service with U.S. Navy. 1990. *Final Environmental Impact Statement, Endangered Species Management and Protection Plan, Naval Weapons Station-Seal Beach and Seal Beach National Wildlife Refuge.* USFWS, Portland, Oregon, and Navy, Seal Beach, California. August.

Vermeer, K., F. A. J. Armstrong, and D. R. M. Hatch. 1973. Mercury in Aquatic Birds at Clay Lake, Western Ontario. *Journal of Wildlife Management* 37:58-61.

Weseloh, D., T. W. Custer, and B. M. Braune. 1989. Organochlorine Contaminants in Eggs of Common Terns from the Canadian Great Lakes, 1981. *Environmental Pollution* 59:141-160.

White, D. H., and M. P. Dieter. 1978. Effects of Dietary Vanadium in Mallard Ducks. *Journal of Toxicology and Environmental Health* 4:43-50.

White, D. H., and M. T. Finley. 1978. Effects of Dietary Cadmium in Mallard Ducks. Trace Substances in Environmental Health XII. A symposium. D. D. Hemphill, ed. University of Missouri, Columbia. Pp. 220-223.

White D. H., M. T. Finley, and J. F. Ferrell. 1978. Histopathologic Effects of Dietary Cadmium on Kidneys and Testes of Mallard Ducks. *Journal of Toxicology and Environmental Health* 4:551-558.

Zembal, R., and J. M. Fancher. 1988. Foraging Behavior and Foods of the Light-footed Clapper Rail. *Condor* 90:959-962.

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Attachment 1

CHEMICALS OF CONCERN

IDENTIFIED IN VARIOUS OPERABLE UNITS AT

NWS SEAL BEACH

Table 6-2
Site 05 Analytes Detected in Soil (mg/kg)
Naval Weapons Station Seal Beach
OU4 Site Inspection Report

SAMPLE CODE 1	BCKD									
STATION ID	05_H06	05_H03	05_H04	05_H04	05_H04	05_H05	05_MW01	05_MW01	05_MW02	05_MW02
SAMPLE ID	05-H0064-1	05-H0030-1	05-H0040-1	05-H0040-2	05-H0041-1	05-H0050-1	05-G0010-1	05-G0010-2	05-B0020-1	05-B0020-2
UPPER DEPTH (ft bgs)	0.2	0.5	0.5	3.75	1.1	0.5	0.5	3.5	0.5	2.5
VOLATILE ORGANIC COMPOUNDS										
2-BUTANONE								0.015		
ACETONE		0.009 J	0.005 J	0.037			0.011 J	0.056		
METHANE, CHLORODIFLUORO	0.011 JN	0.011 JN	0.009 JN (BBL)	0.062 JN	0.01 JN (BBL)	0.009 JN (BBL)	0.016 JN			
TOLUENE							0.016	0.023	0.025	0.039
SEMIVOLATILE ORGANIC COMPOUNDS										
2-PENTANONE,4-HYDROXY-4-METHYL							6.7 JBN	6.1 JBN		
BIS(2-ETHYLHEXYL)PHTHALATE									0.068 J	0.029 J
UNKNOWN	2.8 J	0.011 J (BBL)	0.009 J (BBL)	1.4 J` (BBL)	0.008 J (BBL)	0.4 J (BBL)	0.005 J (BBL)	0.31 J (BBL)	0.096 J (BBL)	0.11 J (BBL)
UNKNOWN HEXANEDIOIC ACID ISO										0.19 J
UNKNOWN HYDROCARBON	1.7 J	0.54 J (BBL)		1.3 J (BBL)		1.3 J (BBL)		1 J (BBL)	0.077 J (BBL)	0.31 J (BBL)
PESTICIDES/PCBs										
4,4'-DDD	0.00506		0.00405 (BBL)		0.0276					
4,4'-DDE	0.0156	0.0219	0.0262		0.242 EC					
4,4'-DDT	0.0301 J	0.0114 J (BBL)	0.00716 J (BBL)		0.271 ECJ					
ALPHA-CHLORDANE					0.0226					
GAMMA-CHLORDANE			0.000198		0.0199					
METALS										
ALUMINUM	19400	10900 (BBL)	24400	15200 (BBL)	16900 (BBL)	21700	9220 * (BBL)	15500 * (BBL)	6020 * (BBL)	14800 * (BBL)
ANTIMONY									4.7 B	
ARSENIC	20.5	2.7 (BBL)	5.8 S (BBL)	6.4 (BBL)	4.6 (BBL)	12 S (BBL)	2.4 N (BBL)	2.6 N (BBL)	6.2 BWN (BBL)	5.5 N (BBL)
BARIUM	144	34.8 B (BBL)	190	69.9 B (BBL)	83 (BBL)	217	48.2 (BBL)	108 (BBL)	62 (BBL)	106 (BBL)
BERYLLIUM	0.87 B	0.43 B (BBL)	1 B	0.72 B (BBL)	0.77 B (BBL)	0.81 B (BBL)				
CADMIUM	0.97 B	0.45 B (BBL)	1.4	0.82 B (BBL)	0.72 B (BBL)	2.2			4.2 *	
CALCIUM	16200 *	8880 * (BBL)	27100 *	6900 * (BBL)	15700 * (BBL)	21100 *	2910 * (BBL)	3180 * (BBL)	45700 *	6090 * (BBL)
CHROMIUM	27.2	17.4 (BBL)	41.7	24.7 (BBL)	32.1	62.7	13.2 N* (BBL)	28.3 N*	49.3 N*	30 N*
COBALT	11 B	5.7 B (BBL)	13.6	8.7 B (BBL)	11.4 B	11.5 B	12.7	8.9 B (BBL)	8 B (BBL)	10.7 B (BBL)
COPPER	31.6 E	24.5 E (BBL)	45.2 E	26.5 E (BBL)	38.8 E	135 E	11.3 N* (BBL)	15.9 N* (BBL)	226 N*	20.7 N* (BBL)
IRON	29400	15400 (BBL)	33100	22700 (BBL)	25100 (BBL)	61600	13700 * (BBL)	20500 * (BBL)	87100 *	23100 * (BBL)
LEAD	35.9 *	15.7 * (BBL)	14.1 * (BBL)	14.2 * (BBL)	24 * (BBL)	210 *	12.6 * (BBL)	7 * (BBL)	37.7 *	16 * (BBL)
MAGNESIUM	9330	5760 (BBL)	15100	9640	12400	11700	3550 (BBL)	5470 (BBL)	3020 (BBL)	5950 (BBL)
MANGANESE	714	240 (BBL)	714	358 (BBL)	562 (BBL)	1040	293 N* (BBL)	361 N* (BBL)	333 N* (BBL)	471 N* (BBL)
MERCURY								5 J		
NICKEL	22.2	13.6 (BBL)	25.8	19.4 (BBL)	22.2	81.2	12.6 N* (BBL)	21.2 N* (BBL)	108 N*	
POTASSIUM	5420	3180 (BBL)	7150	5300 (BBL)	5890	6630	2400 (BBL)	3020 (BBL)		3640 (BBL)
SILVER									0.94 B	
SODIUM	475 B	2490	5460	13400	4600	11700	2350	3860	614 B	441 B (BBL)
VANADIUM	56.8	30.8 (BBL)	63.7	45.5 (BBL)	46.6 (BBL)	61.1	27.4 (BBL)	37.1 (BBL)	16.1 (BBL)	43 (BBL)
ZINC	98.7	55.9 (BBL)	107	70.8 (BBL)	118	889	37.8 * (BBL)	50.4 * (BBL)	1640 *	99 *

(BBL) = Below Background Level
Lab qualifiers defined in Appendix E

Table 6-3
Site 05 Groundwater Detections (ug/l)
Naval Weapons Station Seal Beach
OU4 Site Inspection Report

STATION_ID		05_MW01	05_MW02	05_MW02	USGS_MW05	USGS_MW29	USGS_MW29
SAMPLE_ID	MCLs	05-G0010	05-G0021	05-G0020	05-G0050	05-G0290I	05-G0290
VOLATILE ORGANIC COMPOUNDS							
ACETONE		7 J					
TOLUENE		4 J		1 J	2 J	2 J	
SEMIVOLATILE ORGANIC COMPOUNDS							
4-METHYLPHENOL		0.7 J					
BIS(2-ETHYLHEXYL)PHTHALATE		1 J				0.8 J	
DI-N-BUTYL PHTHALATE		0.6 J		1 J			
METALS							
ALUMINUM			38 B	90.8 B	47.4 B		
ANTIMONY		62.5					51.7 B
ARSENIC	**50**		38.6	42.1	5.6 B		
BARIUM	**1000**	416	26.7 B	22.2 B	88.8 B		48.2 B
CALCIUM		546000	30600	28700	57800		560000
COBALT		8.7 B					
IRON		111					
MAGNESIUM		1470000	16600	15800	23100		829000
MANGANESE		2230	7.1 B	7.4 B	8.2 B		1390
NICKEL							12.7 B
POTASSIUM		313000	4060 B	4040 B			164000
SODIUM		10600000	279000	274000	242000		7090000
VANADIUM		9.8 B	27.3 B	27.9 B	20 B		7.2 B

Lab qualifiers defined in Appendix E

TABLE 7-1
Analytes Detected in Soil--Site 8
Metals, Oil and Grease, and pH
NWS Seal Beach, Seal Beach, California
(Sheet 1 of 2)

ANALYTE	BACKGROUND 08H007A0-1 (mg/kg)	BACKGROUND 08H008A0-1 (mg/kg)	PRG (mg/kg)	SAMPLE NUMBERS 08H001A0-1 (mg/kg)	08H001A0-2 (mg/kg)	08H001A1-2 (mg/kg)	08H002A0-1 (mg/kg)	08H002A0-2 (mg/kg)	08H003A0-1 (mg/kg)
METALS									
ALUMINUM	10,100.00	30,800.00	7.80E+04	8,140.00	9,620.00	13,000.00	8,460.00	11,800.00	10,100.00
ARSENIC	1.90	ND	9.70E-01	3.90	3.30	2.60	1.30	3.00	15.50
BARIUM	56.00	172.00	5.50E+03	71.50	61.10	83.20	60.30	71.60	66.70
BERYLLIUM	ND	1.00	4.00E-01	ND	ND	ND	ND	ND	ND
CADMIUM	1.00	ND	3.90E+01	1.20	ND	ND	0.99	ND	1.10
CALCIUM	1,990.00	7,510.00		5,520.00	1,860.00	1,520.00	2,010.00	2,820.00	2,650.00
CHROMIUM	17.80	33.90	3.90E+02	13.20	17.80	22.50	16.00	19.30	17.50
COBALT	7.80	12.30		8.20	9.20	9.60	6.30	10.80	5.80
COPPER	13.00	20.30	2.90E+03	15.80	10.70	13.00	12.20	14.20	22.50
IRON	16,300.00	31,600.00		16,500.00	16,600.00	20,700.00	14,700.00	19,200.00	15,200.00
LEAD	4.30	5.00	5.00E+02	4.80	4.20	5.50	5.30	4.90	218.00
MAGNESIUM	5,120.00	8,640.00		4,200.00	4,560.00	5,520.00	4,320.00	5,020.00	3,660.00
MANGANESE	373.00	628.00	3.90E+02	258.00	1,100.00	487.00	365.00	485.00	182.00
MERCURY	ND	ND	2.30E+02	ND	ND	ND	ND	ND	ND
NICKEL	10.70	22.90	1.60E+03	14.10	12.20	15.80	10.50	16.70	15.00
POTASSIUM	3,560.00	5,210.00		780.00	3,120.00	3,310.00	3,600.00	3,060.00	2,410.00
SELENIUM	ND	ND	3.90E+02	0.88 (N)	ND	ND	0.31	0.58 (N)	ND
SODIUM	6,720.00	3,220.00		277.00	1,470.00	2,000.00	591.00	985.00	1,810.00
THALLIUM	0.89	0.99		0.76	0.75	0.90	0.79	0.99	1.20
VANADIUM	33.40	64.10	5.50E+02	25.80	35.90	42.00	29.40	40.20	32.80
ZINC	37.90	69.50	2.30E+03	44.60	38.80	47.70	37.00	44.80	92.00
GENERAL CHEMISTRY									
OIL AND GREASE	ND	ND		ND	12.00	ND	ND	17.00	230.00
pH	9.00	8.90		9.00	8.60	8.90	8.40	8.80	8.70

TABLE 7-1
Analytes Detected in Soil–Site 8
Metals, Oil and Grease, and pH
NWS Seal Beach, Seal Beach, California
(Sheet 2 of 2)

ANALYTE	BACKGROUND 08H007A0-1 (mg/kg)	BACKGROUND 08H008A0-1 (mg/kg)	PRG (mg/kg)	SAMPLE NUMBERS 08H004A0-1 (mg/kg)	08H005A0-1 (mg/kg)	08H005A0-2 (mg/kg)	08H006A0-1 (mg/kg)	08H006A0-2 (mg/kg)
METALS								
ALUMINUM	10,100.00	30,800.00	7.80E+04	21,200.00	19,600.00	12,600.00	23,700.00	17,500.00
ARSENIC	1.90	ND	9.70E-01	5.10	5.30	5.60	5.40	7.50
BARIUM	56.00	172.00	5.50E+03	115.00	124.00	121.00	120.00	196.00
BERYLLIUM	ND	1.00	4.00E-01	0.88	0.80	ND	0.98	ND
CADMIUM	1.00	ND	3.90E+01	ND	0.87	1.60	0.94	2.00
CALCIUM	1,990.00	7,510.00		5,530.00	7,020.00	3,570.00	2,620.00	5,030.00
CHROMIUM	17.80	33.90	3.90E+02	30.00	32.10	56.70	31.30	37.60
COBALT	7.80	12.30		11.40	12.30	7.90	14.80	9.80
COPPER	13.00	20.30	2.90E+03	17.90	29.30	54.20	21.90	43.30
IRON	16,300.00	31,600.00		26,800.00	26,900.00	23,200.00	30,000.00	24,600.00
LEAD	4.30	5.00	5.00E+02	9.80	96.00	297.00	10.10	313.00
MAGNESIUM	5,120.00	8,640.00		6,880.00	7,190.00	5,780.00	7,460.00	7,260.00
MANGANESE	373.00	628.00	3.90E+02	529.00	691.00	256.00	655.00	351.00
MERCURY	ND	ND	2.30E+02	ND	ND	0.25	ND	ND
NICKEL	10.70	22.90	1.60E+03	21.10	19.80	14.20	24.50	20.90
POTASSIUM	3,560.00	5,210.00		4,010.00	4,020.00	2,380.00	4,760.00	4,500.00
SELENIUM	ND	ND	3.90E+02	ND	ND	ND	ND	ND
SODIUM	6,720.00	3,220.00		977.00	1,920.00	369.00	2,680.00	574.00
THALLIUM	0.89	0.99		1.10	1.20	0.79	1.30	0.95
VANADIUM	33.40	64.10	5.50E+02	54.80	54.00	44.70	61.50	51.20
ZINC	37.90	69.50	2.30E+03	62.40	108.00	154.00	68.40	293.00
GENERAL CHEMISTRY								
OIL AND GREASE	ND	ND		19.00	180.00	2,600.00	22.00	3,500.00
pH	9.00	8.90		8.90	8.10	7.70	8.10	7.50

Shaded concentrations indicate the value is above the background screening level (see text Section 5.4), except those analytes detected in the method blanks.

Not all analytes tested for are listed; those not listed were not detected (ND). For a complete list of analytes requested and tested, see Appendix C.

N -- Spiked sample, recovery not within control limits.

PRG -- Preliminary remediation goal, 4th quarter, 1993, residential soil classification.

TABLE 7-2
Analytes Detected in Soil–Site 8
Volatile and Semivolatile Organics
NWS Seal Beach, Seal Beach, California
(Sheet 1 of 2)

ANALYTE	BACKGROUND 08H007A0-1 (ug/kg)	BACKGROUND 08H008A0-1 (ug/kg)	PRG (ug/kg)	SAMPLE NUMBERS 08H001A0-1 (ug/kg)	08H001A0-2 (ug/kg)	08H001A1-2 (ug/kg)	08H002A0-1 (ug/kg)	08H002A0-2 (ug/kg)	08H003A0-1 (ug/kg)
SEMIVOLATILE ORGANICS									
2-CHLOROPHENOL	ND	ND	2.00E+05	ND	ND	ND	ND	ND	11.00
2,4-DIMETHYLPHENOL	ND	ND	7.80E+05	ND	ND	ND	ND	ND	ND
2-METHYLNAPHTHALENE	ND	ND		ND	ND	ND	ND	ND	770.00
4-METHYLPHENOL	ND	ND	2.00E+05	ND	ND	ND	ND	ND	ND
ANTHRACENE	ND	ND		ND	ND	ND	ND	ND	8.00
BENZO(A)PYRENE	ND	ND		ND	ND	ND	ND	ND	ND
BENZO(G,H,I)PERYLENE	ND	ND		ND	ND	ND	ND	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	3421(B)	11(B)	6.10E+04	31(B)	36(B)	49(B)	150(B)	1777(B)	3620(B)
BUTYLBENZYLPHTHALATE	1810(B)		7.80E+05	45(B)	76(B)	136(B)	370(B)	1522(B)	1863(B)
DI-N-BUTYLPHTHALATE	2877(B)	120(B)		3904(B)	3967(B)	3536(B)	3884(B)	3891(B)	2121(B)
DIETHYLPHTHALATE	ND	ND	3.10E+07	ND	ND	ND	ND	ND	ND
FLUORANTHENE	ND	ND		ND	ND	ND	ND	ND	15.00
NAPHTHALENE	ND	ND		ND	ND	ND	ND	ND	324.00
PHENANTHRENE	ND	ND		ND	ND	ND	ND	ND	30.00
PYRENE	ND	ND	1.20E+06	ND	ND	ND	ND	ND	28.00
VOLATILE ORGANICS									
ACETONE	ND	ND	9.20E+06	ND	ND	ND	ND	ND	147.00
2-BUTANONE	ND	ND	5.20E+06	ND	ND	ND	ND	ND	15.00
METHYLENE CHLORIDE	ND	ND	2.20E+04	ND	ND	ND	3.00	ND	ND
TETRACHLOROETHENE	ND	ND	2.20E+04	ND	ND	ND	ND	ND	12.00
TOLUENE	1.00	ND	2.80E+05	ND	ND	ND	ND	ND	ND

TABLE 7-2
Analytes Detected in Soil--Site 8
Volatile and Semivolatile Organics
NWS Seal Beach, Seal Beach, California
(Sheet 2 of 2)

ANALYTE	BACKGROUND 08H007A0-1 (ug/kg)	BACKGROUND 08H008A0-1 (ug/kg)	PRG (ug/kg)	SAMPLE NUMBERS 08H004A0-1 (ug/kg)	08H005A0-1 (ug/kg)	08H005A0-2 (ug/kg)	08H006A0-1 (ug/kg)	08H006A0-2 (ug/kg)
SEMIVOLATILE ORGANICS								
2-CHLOROPHENOL	ND	ND	2.00E+05	ND	ND	ND	ND	ND
2,4-DIMETHYLPHENOL	ND	ND	7.80E+05	ND	ND	ND	ND	36.00
2-METHYLNAPHTHALENE	ND	ND		ND	ND	ND	ND	ND
4-METHYLPHENOL	ND	ND	2.00E+05	ND	ND	26.00	ND	19.00
ANTHRACENE	ND	ND		ND	ND	ND	ND	ND
BENZO(A)PYRENE	ND	ND		ND	21.00	110.00	ND	ND
BENZO(G,H,I)PERYLENE	ND	ND		ND	ND	262.00	ND	271.00
BIS(2-ETHYLHEXYL)PHTHALATE	3421(B)	11(B)	6.10E+04	2860(B)	3607(B)	65(B)	4182(B)	128(B)
BUTYLBENZYLPHTHALATE	1810(B)		7.80E+05	1834(B)	2121(B)	ND	2050(B)	ND
DI-N-BUTYLPHTHALATE	2877(B)	120(B)		3404(B)	2951(B)	196(B)	2262(B)	164(B)
DIETHYLPHTHALATE	ND	ND	3.10E+07	ND	ND	12.00	ND	ND
FLUORANTHENE	ND	ND		ND	ND	ND	ND	ND
NAPHTHALENE	ND	ND		ND	ND	ND	ND	ND
PHENANTHRENE	ND	ND		ND	ND	ND	ND	ND
PYRENE	ND	ND	1.20E+06	10.00	6.00	21.00	ND	22.00
VOLATILE ORGANICS								
ACETONE	ND	ND	9.20E+06	ND	ND	ND	ND	ND
2-BUTANONE	ND	ND	5.20E+06	ND	ND	ND	ND	ND
METHYLENE CHLORIDE	ND	ND	2.20E+04	ND	ND	ND	ND	ND
TETRACHLOROETHENE	ND	ND	2.20E+04	ND	ND	ND	ND	ND
TOLUENE	1.00	ND	2.80E+05	ND	ND	ND	ND	ND

Shaded concentrations indicate the value is above the background screening level (see text Section 5.4), except those analytes detected in the method blanks.
Not all analytes tested for are listed; those not listed were not detected (ND). For a complete list of analytes requested and tested, see Appendix C.
B -- Analyte is found in the associated blank as well as in the sample.
PRG -- Preliminary remediation goal, 4th quarter, 1993, residential soil classification.

TABLE 7-3
Analytes Detected In Groundwater - Site 8
NWS Seal Beach, California

ANALYTE	MCL (EPA) (µg/l)	MCL (DHS) (µg/l)	08GB21A0-1 (µg/l)	Q	08GB28A0-1 (µg/l)	Q	08GB28A1-1 (µg/l)	Q
METALS								
ALUMINUM		1,000.00	121.00	B	119.00	B	128.00	B
BARIUM		1,000.00	75.30	B	72.80	B	72.30	B
CADMIUM	5.00	10.00	6.00		ND		ND	
CALCIUM			133,000.00	E	351,000.00	E	348,000.00	E
IRON			54.80	B	ND		ND	
MAGNESIUM			61,100.00		382,000.00		380,000.00	
MANGANESE			19.60	E	1,460.00	E	1,430.00	E
POTASSIUM			ND		2,870.00	B	3,380.00	B
SELENIUM	50.00	10.00	3.90	BN	8.10	BN	ND	
SODIUM			624,000.00		4,320,000.00		4,210,000.00	
THALLIUM	2.00		ND		ND		2.60	BN
VANADIUM			18.30	B	ND		14.40	B
GENERAL CHEMISTRY								
OIL AND GREASE			4,000.00		3,000.00		3,000.00	
pH			7.10		7.10		7.10	
VOLATILE ORGANICS								
1,2-DICHLOROETHANE	5.00	0.50	4.00	J	17.00		17.00	
METHYLENE CHLORIDE	5.00		ND		ND		3.00	J

Not all analytes tested for are listed. Those not listed were not detected (ND).
For a complete list of analytes requested and tested for, see Table 5-4 and Appendix C.
Shaded concentrations indicate the value is above an MCL.

EPA - Environmental Protection Agency.
DHS - California Department of Health Services.
MCL - Maximum contaminant level.

Q - Qualifier.
B - Analyte is found in the associated blank as well as in the sample.
E - Concentration exceeds the calibration range of the gas chromatography/mass spectroscopy (GC/MS) instrument.
N - Indicates presumptive evidence of a compound.
J - Indicates an estimated value, less than the contract-required quantitation limit (CRQL) and greater than zero.

TABLE 7-5
Analytes Detected in Soil--Site 12
Metals and Nitrogen
NWS Seal Beach, Seal Beach, California
(Sheet 1 of 4)

ANALYTE	BACKGROUND 12H018A0-1 (mg/kg)	PRG (mg/kg)	SAMPLE NUMBERS 12H001A0-1 (mg/kg)	12H001A1-1 (mg/kg)	12H002A0-1 (mg/kg)	12H003A0-1 (mg/kg)	12H003A0-2 (mg/kg)	12H004A0-1 (mg/kg)	12H004A0-2 (mg/kg)	12H005A0-1 (mg/kg)
METALS										
ALUMINUM	12,200.00	7.80E+04	14,400.00	11,100.00	8,260.00	16,300.00	17,600.00	13,400.00	9,280.00	14,100.00
ANTIMONY	ND	3.10E+01	ND	ND	ND	ND	ND	ND	ND	ND
ARSENIC	3.60	9.70E-01	2.70	2.40	3.70	6.20	6.90	6.20	6.10	3.00
BARIUM	91.00	5.50E+03	97.80	85.80	89.30	109.00	155.00	102.00	98.90	152.00
CALCIUM	13,200.00		6,530.00	4,980.00	7,820.00	12,500.00	22,200.00	4800 (*)	15700 (*)	7470 (*)
CHROMIUM	24.20	3.90E+02	30.90	22.70	20.70	36.70	25.70	20.50	16.90	28.10
COBALT	8.90		8.50	7.10	5.60	7.20	9.50	6.90	6.30	6.50
COPPER	20.50	2.90E+03	20.20	16.30	12.70	22.00	28.50	24.20	410.00	20.30
IRON	22,900.00		25,100.00	19,600.00	13,700.00	27,900.00	23,900.00	23,500.00	14,400.00	24,300.00
LEAD	3.70	5.00E+02	4.00	3.50	20.70	6.00	86.70	4.20	80.40	3.40
MAGNESIUM	6,540.00		6,680.00	5,470.00	4,280.00	7,560.00	9,370.00	5,290.00	4,870.00	7,010.00
MANGANESE	429.00	3.90E+02	241.00	226.00	254.00	269.00	432.00	231.00	236.00	223.00
MERCURY	ND	2.30E+02	ND	ND	ND	ND	ND	ND	0.15	ND
NICKEL	26.70	1.60E+03	16.80	14.80	12.20	20.70	18.70	14.00	10.70	18.90
POTASSIUM	4,870.00		4,580.00	3,850.00	2,020.00	4,810.00	5,150.00	3,180.00	2,350.00	5,260.00
SELENIUM	ND	3.90E+02	ND	ND	0.57	ND	ND	ND	ND	ND
SODIUM	955.00		1,300.00	968.00	784.00	1,150.00	2,390.00	1,900.00	1,700.00	2,000.00
THALLIUM	1.20		1.20	0.91	1.30	1.00	0.93	ND	0.66	1.10
VANADIUM	30.40	5.50E+02	42.70	33.40	35.70	50.70	48.90	44.30	26.80	41.10
ZINC	64.80	2.30E+04	61.90	53.70	58.10	66.60	121.00	363.00	135.00	57.60
NITROGEN										
TKN	72.50		475.00	273.00	1,460.00	114.00	349.00	256.00	137.00	88.20
AMMONIA	4.00		1.20	2.10	9.90	5.50	11.10	ND	9.90	ND
NITRATE	2.76	1.00E+05	ND	0.55	ND	0.12	ND	0.16	ND	ND

TABLE 7-5
Analytes Detected in Soil--Site 12
Metals and Nitrogen
NWS Seal Beach, Seal Beach, California
(Sheet 2 of 4)

ANALYTE	BACKGROUND 12H016A0-1 (mg/kg)	PRG (mg/kg)	SAMPLE NUMBERS 12H005A0-2 (mg/kg)	12H005A1-2 (mg/kg)	12H006A0-1 (mg/kg)	12H006A0-2 (mg/kg)	12H007A0-1 (mg/kg)	12H008A0-1 (mg/kg)	12H008A0-2 (mg/kg)	12H008A1-1 (mg/kg)
METALS										
ALUMINUM	12,200.00	7.80E+04	10,700.00	14,500.00	7,870.00	10,900.00	12,500.00	8,530.00	9,890.00	9,280.00
ANTIMONY	ND	3.10E+01	ND	ND	ND	ND	ND	ND	ND	ND
ARSENIC	3.60	9.70E-01	2.30	2.80	2.90	6.80	5.80	2.90	3.40	3.60
BARIUM	91.00	5.50E+03	145.00	159.00	72.10	120.00	109.00	81.10	88.30	81.00
CALCIUM	13,200.00		7440 (*)	4070 (*)	6080 (*)	7860 (*)	8280 (*)	3490 (*)	6480 (*)	5500 (*)
CHROMIUM	24.20	3.90E+02	17.60	19.90	12.30	18.80	20.50	11.60	14.90	14.20
COBALT	8.90		7.10	8.50	5.10	8.20	7.80	4.90	6.00	6.30
COPPER	20.50	2.90E+03	17.50	15.00	10.20	21.70	87.40	9.70	13.30	11.90
IRON	22,900.00		15,300.00	17,000.00	13,900.00	17,400.00	20,200.00	16,200.00	18,600.00	17,300.00
LEAD	3.70	5.00E+02	41.30	47.40	4.50	27.20	86.40	3.30	4.60	3.10
MAGNESIUM	6,540.00		3,890.00	3,930.00	3,540.00	6,130.00	5,910.00	3,580.00	5,590.00	4,520.00
MANGANESE	429.00	3.90E+02	218.00	217.00	163.00	299.00	307.00	176.00	168.00	183.00
MERCURY	ND	2.30E+02	0.10	ND	ND	ND	ND	ND	ND	0.16
NICKEL	26.70	1.60E+03	14.20	13.90	7.00	19.70	13.40	6.60	14.70	9.10
POTASSIUM	4,870.00		2,450.00	2,680.00	2,540.00	2,920.00	3,270.00	2,570.00	3,700.00	2,930.00
SELENIUM	ND	3.90E+02	ND	ND	ND	ND	ND	ND	ND	ND
SODIUM	955.00		2,130.00	1,960.00	901.00	1,340.00	1,670.00	1,050.00	1,350.00	978.00
THALLIUM	1.20		0.74	0.61	0.58	0.77	1.10	0.74	0.86	0.82
VANADIUM	30.40	5.50E+02	29.90	35.90	25.20	46.30	37.20	23.80	30.70	29.20
ZINC	64.80	2.30E+04	140.00	60.20	37.80	66.70	96.80	31.30	39.40	37.50
NITROGEN										
TKN	72.50		1,650.00	505.00	50.70	133.00	196.00	26.80	130.00	42.30
AMMONIA	4.00		7.70	6.60	ND	ND	1.60	ND	ND	ND
NITRATE	2.76	1.00E+05	ND	ND	0.11	ND	ND	1.00	0.24	0.74

TABLE 7-5
Analytes Detected in Soil--Site 12
Metals and Nitrogen
NWS Seal Beach, Seal Beach, California
(Sheet 3 of 4)

ANALYTE	BACKGROUND 12H018A0-1 (mg/kg)	PRG (mg/kg)	SAMPLE NUMBERS 12H009A0-1 (mg/kg)	12H009A0-2 (mg/kg)	12H010A0-1 (mg/kg)	12H010A0-2 (mg/kg)	12H011A0-1 (mg/kg)	12H011A0-2 (mg/kg)	12H012A0-1 (mg/kg)	12H012A0-2 (mg/kg)
METALS										
ALUMINUM	12,200.00	7.80E+04	7,810.00	9,440.00	17,200.00	9,630.00	9,450.00	12,200.00	11,000.00	9,210.00
ANTIMONY	ND	3.10E+01	ND	ND	13.30	ND	ND	ND	ND	ND
ARSENIC	3.60	9.70E-01	2.50	2.80	3.80	5.90	2.30	11.50	2.50	3.20
BARIUM	91.00	5.50E+03	69.30	89.10	107.00	113.00	97.80	133.00	92.60	81.30
CALCIUM	13,200.00		1820 (*)	9430 (*)	7450 (*)	25600 (*)	3020 (*)	22100 (*)	8340 (*)	5320 (*)
CHROMIUM	24.20	3.90E+02	7.60	16.30	35.90	15.90	12.60	20.30	17.40	15.00
COBALT	8.90		6.90	6.10	7.90	6.30	6.60	7.00	4.40	5.40
COPPER	20.50	2.90E+03	11.50	11.50	23.50	30.80	11.20	22.80	12.7 (*)	12.1 (*)
IRON	22,900.00		20,800.00	18,300.00	25,700.00	13,500.00	16,400.00	16,500.00	19,800.00	15,900.00
LEAD	3.70	5.00E+02	3.10	4.60	4.10	35.70	2.70	100.00	3.1 (*)	11 (*)
MAGNESIUM	6,540.00		2,990.00	6,610.00	7,050.00	5,130.00	3,790.00	5,530.00	5,940.00	4,520.00
MANGANESE	429.00	3.90E+02	242.00	196.00	275.00	268.00	187.00	339.00	201 (N)	242 (N)
MERCURY	ND	2.30E+02	ND	ND	ND	0.27	ND	ND	ND	ND
NICKEL	26.70	1.60E+03	8.70	21.10	19.20	8.60	10.00	12.20	11.10	11.80
POTASSIUM	4,870.00		2,430.00	2,830.00	5,500.00	2,370.00	2,520.00	2,980.00	3,370.00	2,930.00
SELENIUM	ND	3.90E+02	ND	ND	ND	ND	ND	ND	ND	ND
SODIUM	955.00		817.00	961.00	2,000.00	1,530.00	1,120.00	1,390.00	1,170.00	873.00
THALLIUM	1.20		0.92	1.00	1.30	0.54	0.62	0.57	1.20	0.97
VANADIUM	30.40	5.50E+02	22.20	28.80	51.70	26.90	29.40	35.20	30.30	28.00
ZINC	64.80	2.30E+04	39.20	38.50	64.80	134.00	43.60	210.00	43.90	54.40
NITROGEN										
TKN	72.50		60.60	83.60	53.40	191.00	144.00	612.00	267.00	327.00
AMMONIA	4.00		ND	ND	ND	7.30	1.20	1.30	2.00	2.00
NITRATE	2.76	1.00E+05	ND	ND	ND	0.68	0.83	0.41	1.87	0.47

TABLE 7-5
Analytes Detected in Soil--Site 12
Metals and Nitrogen
NWS Seal Beach, Seal Beach, California
(Sheet 4 of 4)

ANALYTE	BACKGROUND 12H016A0-1 (mg/kg)	PRG (mg/kg)	SAMPLE NUMBERS 12H013A0-1 (mg/kg)	12H013A0-2 (mg/kg)	12H013A1-1 (mg/kg)	12H014A0-1 (mg/kg)	12H014A0-2 (mg/kg)	12H015A0-1 (mg/kg)	12H015A0-2 (mg/kg)
METALS									
ALUMINUM	12,200.00	7.80E+04	14,000.00	6,360.00	14,000.00	10,200.00	10,800.00	11,800.00	11,800.00
ANTIMONY	ND	3.10E+01	ND	ND	ND	ND	ND	ND	ND
ARSENIC	3.60	9.70E-01	4.30	4.30	6.40	4.60	3.10	3.40	4.40
BARIUM	91.00	5.50E+03	98.70	52.10	103.00	80.50	72.80	105.00	100.00
CALCIUM	13,200.00		11400 (*)	43000 (*)	23400 (*)	9810 (*)	11500 (*)	11000 (*)	14600 (*)
CHROMIUM	24.20	3.90E+02	24.30	11.60	20.50	14.20	18.80	19.20	24.00
COBALT	8.90		7.70	2.90	6.10	3.60	4.40	6.00	6.10
COPPER	20.50	2.90E+03	47.5 (*)	11 (*)	39.8 (*)	25.2 (*)	13.3 (*)	22.8 (*)	33.8 (*)
IRON	22,900.00		23,100.00	8,960.00	17,300.00	17,500.00	18,100.00	24,600.00	20,700.00
LEAD	3.70	5.00E+02	13.9 (*)	13.3 (*)	33.4 (*)	3.2 (*)	14.8 (*)	3.3 (*)	35.6 (*)
MAGNESIUM	6,540.00		7,780.00	3,370.00	6,070.00	5,730.00	5,340.00	7,540.00	6,900.00
MANGANESE	429.00	3.90E+02	288 (N)	135 (N)	303 (N)	175 (N)	190 (N)	299 (N)	286 (N)
MERCURY	ND	2.30E+02	ND	ND	ND	ND	0.09	ND	ND
NICKEL	26.70	1.60E+03	15.20	8.20	15.10	9.10	17.10	11.70	16.50
POTASSIUM	4,870.00		3,880.00	1,620.00	3,290.00	2,470.00	3,080.00	3,620.00	3,270.00
SELENIUM	ND	3.90E+02	ND	ND	ND	ND	ND	ND	ND
SODIUM	955.00		2,160.00	1,570.00	1,980.00	1,380.00	1,480.00	1,750.00	1,390.00
THALLIUM	1.20		0.91	0.48	0.89	0.99	0.83	1.20	ND
VANADIUM	30.40	5.50E+02	48.40	20.60	38.80	31.00	35.30	39.50	42.60
ZINC	64.80	2.30E+04	80.20	34.10	96.10	42.40	51.20	51.00	103.00
NITROGEN									
TKN	72.50		1,180.00	335.00	1,130.00	252.00	412.00	177.00	544.00
AMMONIA	4.00		18.80	17.00	34.20	7.90	8.80	8.60	19.30
NITRATE	2.76	1.00E+05	ND	0.25	ND	ND	5.04	0.86	3.20

Shaded concentrations indicate the value is above the background screening level (see text Section 5.4), except those analytes detected in the method blanks.

Not all analytes tested for are listed; those not listed were not detected (ND). For a complete list of analytes requested and tested, see Appendix C.

* -- Duplicate analysis not within control limits.

N -- Spiked sample, recovery not within control limits.

PRG -- Preliminary remediation goal, 4th quarter, 1993, residential soil classification.

TABLE 7-6
Analytes Detected in Soil--Site 12
Volatile and Semivolatile Organics
NWS Seal Beach, Seal Beach, California
(Sheet 1 of 4)

ANALYTE	BACKGROUND 12H016A0-1 (ug/kg)	PRG (ug/kg)	SAMPLE NUMBERS 12H001A0-1 (ug/kg)	12H001A1-1 (ug/kg)	12H002A0-1 (ug/kg)	12H003A0-1 (ug/kg)	12H003A0-2 (ug/kg)	12H004A0-1 (ug/kg)	12H004A0-2 (ug/kg)	12H005A0-1 (ug/kg)
VOLATILE ORGANICS										
2-BUTANONE	ND	5.20E+05	NA	NA	NA	NA	ND	NA	42.00	NA
ACETONE	ND	9.20E+05	NA	NA	NA	NA	42.00	NA	187.00	NA
BENZENE	ND	2.70E+03	NA	NA	NA	NA	1.00	NA	ND	NA
CHLOROFORM	5.00	9.60E+02	NA	NA	NA	NA	ND	NA	ND	NA
METHYLENE CHLORIDE	ND	2.20E+04	NA	NA	NA	NA	3.00	NA	ND	NA
TRICHLOROFLUOROMETHANE	ND	4.10E+02	NA	NA	NA	NA	ND	NA	ND	NA
BTEX										
BENZENE	ND	2.70E+03	ND	ND	ND	ND	ND	1.30	1.70	1.80
TOLUENE	4.50	2.80E+05	ND	ND	ND	ND	ND	3.50	5.50	5.90
ETHYLBENZENE	ND	3.10E+05	ND	ND	ND	ND	ND	ND	1.50	1.90
XYLENES	4.10	9.90E+04	ND	ND	ND	ND	ND	4.30	6.70	7.80
PESTICIDES										
4,4'-DDD	ND	3.50E+03	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	ND	2.50E+03	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	ND	2.50E+03	NA	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	ND		NA	NA	NA	NA	NA	NA	NA	NA
DIELDRIN	0.32(P)	5.30E+01	NA	NA	NA	NA	NA	NA	NA	NA
GAMMA-CHLORDANE	ND		NA	NA	NA	NA	NA	NA	NA	NA

TABLE 7-6
Analytes Detected in Soil--Site 12
Volatile and Semivolatile Organics
NWS Seal Beach, Seal Beach, California
(Sheet 2 of 4)

ANALYTE	BACKGROUND 12H016A0-1 (ug/kg)	PRG (ug/kg)	SAMPLE NUMBERS 12H005A0-2 (ug/kg)	12H005A1-2 (ug/kg)	12H006A0-1 (ug/kg)	12H006A0-2 (ug/kg)	12H007A0-1 (ug/kg)	12H008A0-1 (ug/kg)	12H008A0-2 (ug/kg)	12H008A1-1 (ug/kg)
VOLATILE ORGANICS										
2-BUTANONE	ND	5.20E+05	ND	ND	NA	ND	NA	NA	ND	NA
ACETONE	ND	9.20E+05	75.00	92.00	NA	74.00	NA	NA	49.00	NA
BENZENE	ND	2.70E+03	ND	ND	NA	ND	NA	NA	ND	NA
CHLOROFORM	5.00	9.60E+02	ND	ND	NA	ND	NA	NA	ND	NA
METHYLENE CHLORIDE	ND	2.20E+04	ND	ND	NA	ND	NA	NA	ND	NA
TRICHLOROFLUOROMETHANE	ND	4.10E+02	ND	ND	NA	ND	NA	NA	ND	NA
BTEX										
BENZENE	ND	2.70E+03	2.00	1.30	1.70	1.10	ND	ND	ND	ND
TOLUENE	4.50	2.80E+05	8.70	7.20	10.50	4.30	3.90	3.70	7.30	2.60
ETHYLBENZENE	ND	3.10E+05	3.30	3.20	4.40	1.90	ND	ND	2.00	ND
XYLENES	4.10	9.90E+04	11.50	11.10	18.10	6.10	3.40	4.00	8.20	ND
PESTICIDES										
4,4'-DDD	ND	3.50E+03	1.11(P)	0.82	NA	NA	NA	NA	ND	NA
4,4'-DDE	ND	2.50E+03	ND	ND	NA	NA	NA	NA	ND	NA
4,4'-DDT	ND	2.50E+03	ND	ND	NA	NA	NA	NA	ND	NA
BETA-BHC	ND		0.31	ND	NA	NA	NA	NA	ND	NA
DIELDRIN	0.32(P)	5.30E+01	ND	ND	NA	NA	NA	NA	ND	NA
GAMMA-CHLORDANE	ND		ND	ND	NA	NA	NA	NA	ND	NA

TABLE 7-6
Analytes Detected in Soil--Site 12
Volatile and Semivolatile Organics
NWS Seal Beach, Seal Beach, California
(Sheet 3 of 4)

ANALYTE	BACKGROUND 12H016A0-1 (ug/kg)	PRG (ug/kg)	SAMPLE NUMBERS 12H009A0-1 (ug/kg)	12H009A0-2 (ug/kg)	12H010A0-1 (ug/kg)	12H010A0-2 (ug/kg)	12H011A0-1 (ug/kg)	12H011A0-2 (ug/kg)	12H012A0-1 (ug/kg)	12H012A0-2 (ug/kg)
VOLATILE ORGANICS										
2-BUTANONE	ND	5.20E+05	NA	ND	NA	ND	NA	ND	NA	ND
ACETONE	ND	9.20E+05	NA	ND	NA	200.00	NA	ND	NA	ND
BENZENE	ND	2.70E+03	NA	ND	NA	ND	NA	ND	NA	ND
CHLOROFORM	5.00	9.60E+02	NA	ND	NA	ND	NA	ND	NA	ND
METHYLENE CHLORIDE	ND	2.20E+04	NA	ND	NA	ND	NA	ND	NA	ND
TRICHLOROFLUOROMETHANE	ND	4.10E+02	NA	ND	NA	ND	NA	ND	NA	ND
BTEX										
BENZENE	ND	2.70E+03	ND	1.20	0.90	0.90	1.60	0.20	0.90	1.10
TOLUENE	4.50	2.80E+05	3.40	3.10	2.90	3.40	3.00	0.40	2.10	2.20
ETHYLBENZENE	ND	3.10E+05	ND	ND	ND	ND	1.70	ND	ND	ND
XYLENES	4.10	9.90E+04	2.70	1.60	2.70	2.80	5.80	0.30	1.70	2.40
PESTICIDES										
4,4'-DDD	ND	3.50E+03	NA	NA	NA	NA	ND	NA	NA	NA
4,4'-DDE	ND	2.50E+03	NA	NA	NA	NA	ND	NA	NA	NA
4,4'-DDT	ND	2.50E+03	NA	NA	NA	NA	ND	NA	NA	NA
BETA-BHC	ND		NA	NA	NA	NA	ND	NA	NA	NA
DIELDRIN	0.32(P)	5.30E+01	NA	NA	NA	NA	ND	NA	NA	NA
GAMMA-CHLORDANE	ND		NA	NA	NA	NA	ND	NA	NA	NA

TABLE 7-6
Analytes Detected in Soil--Site 12
Volatile and Semivolatile Organics
NWS Seal Beach, Seal Beach, California
(Sheet 4 of 4)

ANALYTE	BACKGROUND 12H016A0-1 (ug/kg)	PRG (ug/kg)	SAMPLE NUMBERS 12H013A0-1 (ug/kg)	12H013A0-2 (ug/kg)	12H013A1-1 (ug/kg)	12H014A0-1 (ug/kg)	12H014A0-2 (ug/kg)	12H015A0-1 (ug/kg)	12H015A0-2 (ug/kg)
VOLATILE ORGANICS									
2-BUTANONE	ND	5.20E+05	NA	ND	NA	NA	ND	NA	ND
ACETONE	ND	9.20E+05	NA	ND	NA	NA	ND	NA	30.00
BENZENE	ND	2.70E+03	NA	ND	NA	NA	ND	NA	ND
CHLOROFORM	5.00	9.60E+02	NA	ND	NA	NA	ND	NA	ND
METHYLENE CHLORIDE	ND	2.20E+04	NA	ND	NA	NA	ND	NA	4.00
TRICHLOROFLUOROMETHANE	ND	4.10E+02	NA	ND	NA	NA	1.00	NA	ND
BTEX									
BENZENE	ND	2.70E+03	1.40	1.20	1.20	2.00	1.00	ND	0.80
TOLUENE	4.50	2.80E+05	4.20	6.30	3.80	13.00	4.90	2.60	2.00
ETHYLBENZENE	ND	3.10E+05	ND	1.60	ND	3.70	1.40	ND	ND
XYLENES	4.10	9.90E+04	2.70	10.00	4.60	22.00	7.80	2.30	1.30
PESTICIDES									
4,4'-DDD	ND	3.50E+03	NA	NA	NA	NA	3.95(P)	NA	NA
4,4'-DDE	ND	2.50E+03	NA	NA	NA	NA	3.63	NA	NA
4,4'-DDT	ND	2.50E+03	NA	NA	NA	NA	12.95	NA	NA
BETA-BHC	ND		NA	NA	NA	NA	ND	NA	NA
DIELDRIN	0.32(P)	5.30E+01	NA	NA	NA	NA	ND	NA	NA
GAMMA-CHLORDANE	ND		NA	NA	NA	NA	0.1(P)	NA	NA

Shaded concentrations indicate the value is above the background screening level (see text Section 5.4), except those analytes detected in the method blanks.

Not all analytes tested for are listed; those not listed were not detected (ND). For a complete list of analytes requested and tested, see Appendix C.

P -- An estimate.

N -- Spiked sample, recovery not within control limits.

PRG -- Preliminary remediation goal, 4th quarter, 1993, residential soil classification.

TABLE 7-7
Analytes Detected In Groundwater - Site 12
NSW Seal Beach, California
(Sheet 1 of 2)

ANALYTE	MCL (EPA) (µg/l)	MCL (DHS) (µg/l)	12GP01A0-1 (µg/l)	Q	12GP02A0-1 (µg/l)	Q	12GP03A0-1 (µg/l)	Q	12GP03A1-1 (µg/l)	Q	12GP04A0-1 (µg/l)	Q
METALS												
ALUMINUM		1,000.00	ND		237.00		ND		ND		ND	
ANTIMONY	6.00		ND		ND		90.10		ND		ND	
ARSENIC	50.00	50.00	ND		48.90	B	ND		33.70	B	30.40	B
BARIUM	2,000.00	1,000.00	137.00	BE	433.00	E	162.00	BE	183.00	BE	727.00	E
CALCIUM			413,000.00	E	344,000.00	E	640,000.00	E	645,000.00	E	356,000.00	E
IRON			ND		12.30	B	2,900.00		1,640.00		165.00	
MAGNESIUM			884,000.00	E	407,000.00	E	1,020,000.00	E	1,040,000.00	E	597,000.00	E
MANGANESE			ND		96.90		2,800.00		2,900.00		878.00	
POTASSIUM			549,000.00	E	364,000.00	E	526,000.00	E	551,000.00	E	378,000.00	E
SODIUM			10,100,000.00		7,160,000.00		11,600,000.00		11,700,000.00		7,690,000.00	
THALLIUM	2.00		14.20	N	ND		ND		7.20	BN	ND	
VANADIUM			25.60	B	11.60	B	19.50	B	23.40	B	ND	
ZINC			ND		ND		559.00		732.00		ND	
GENERAL CHEMISTRY												
AMMONIA (as N)			140.00		1,900.00		4,000.00		3,900.00		17,400.00	
TKN			21,200.00		21,200.00		96,500.00		100,000.00		70,100.00	
PESTICIDES												
4,4'-DDD			0.50	JP	ND		0.01	JP	ND		0.01	JP
4,4'-DDE			0.35	JP	ND		ND		ND		ND	

TABLE 7-7
Analytes Detected in Groundwater - Site 12
NSW Seal Beach, California
(Sheet 2 of 2)

ANALYTE	MCL (EPA) (µg/l)	MCL (DHS) (µg/l)	12GP01A0-1 (µg/l)	Q	12GP02A0-1 (µg/l)	Q	12GP03A0-1 (µg/l)	Q	12GP03A1-1 (µg/l)	Q	12GP04A0-1 (µg/l)	Q
PESTICIDES												
4,4'-DDT			0.19	P	ND		ND		ND		ND	
ALDRIN			2.45	P	ND		ND		ND		ND	
ALPHA-CHLORDANE	2 (tot)	0.1 (tot)	1.69		ND		ND		ND		ND	
GAMMA-CHLORDANE	2 (tot)	0.1 (tot)	2.34		ND		ND		ND		0.03	J P
HEPTACHLOR	0.40	0.01	0.14	JP	ND		ND		ND		ND	
VOLATILE ORGANICS												
CARBON DISULFIDE			ND		2.00	J	ND		ND		2.00	J
ACETONE			ND		ND		ND		39.00		ND	
BENZENE	5.00	1.00	ND		ND		ND		ND		0.20	J
TOLUENE	1.00		ND		ND		ND		0.40	J	0.50	J
XYLENES	10,000.00	1,750.00	ND		ND		ND		ND		0.30	J

Not all analytes tested for are listed. Those not listed were not detected (ND).
For a complete list of analytes requested and tested for, see Table 5-4 and Appendix C.
Shaded concentrations indicate the value is above an MCL.

EPA - Environmental Protection Agency.
DHS - California Department of Health Services.
MCL - Maximum contaminant level.

Q - Qualifier.
B - Analyte is found in the associated blank as well as in the sample.
E - Concentration exceeds the calibration range of the gas chromatography/mass spectroscopy (GC/MS) instrument.
N - Indicates presumptive evidence of a compound.
J - Indicates an estimated value, less than the contract-required quantitation limit (CRQL) and greater than zero.
P - Greater than 25 percent difference between two GC columns and the lower value is reported.

TABLE 7-9
Analytes Detected in Soil--Site 16
Metals and Nitrogen
NWS Seal Beach, Seal Beach, California
(Sheet 1 of 4)

ANALYTE	BACKGROUND 16H014A0-1 (mg/kg)	PRG (mg/kg)	SAMPLE NUMBERS 16H001A0-1 (mg/kg)	16H001A0-2 (mg/kg)	16H002A0-1 (mg/kg)	16H002A0-2 (mg/kg)	16H003A0-1 (mg/kg)	16H003A0-2 (mg/kg)	16H003A1-2 (mg/kg)	16H004A0-1 (mg/kg)
METALS										
ALUMINUM	26,400.00	7.80E+04	14,000.00	2,280.00	26,800.00	3,780.00	29,600.00	2,220.00	2,710.00	8,700.00
ARSENIC	1.90	9.70E-01	3.8 (N)	1.1 (N)	3.8 (N)	1.5 (N)	4.5 (N)	1.2 (N)	1.3 (N)	2 (N)
BARIUM	143.00	5.50E+03	82.70	10.60	170.00	22.40	184.00	11.80	13.30	73.90
BERYLLIUM	0.94	4.00E-01	ND	ND	1.10	ND	1.30	ND	ND	ND
CADMIUM	ND	3.90E+01	ND	ND	ND	ND	ND	0.71	ND	0.74
CALCIUM	14,300.00		17,600.00	1,780.00	53,000.00	4,010.00	52,300.00	7,640.00	2,150.00	7,210.00
CHROMIUM	31.80	3.90E+02	17.40	4.40	30.00	5.50	31.80	3.70	4.50	12.10
COBALT	12.40		7.80	1.80	14.60	3.50	16.10	2.30	2.90	6.80
COPPER	30.60	2.90E+03	22.20	3.30	38.90	4.50	42.30	2.70	3.70	12.50
IRON	33,400.00		19,100.00	3,920.00	33,700.00	7,300.00	37,000.00	4,020.00	4,700.00	13,900.00
LEAD	9.30	5.00E+02	9.7 (N)	1.4 (N)	15.3 (N)	2 (N)	16.7 (N)	1.4 (N)	1.7 (N)	8.4 (N)
MAGNESIUM	15,800.00		8,100.00	1,170.00	13,500.00	1,810.00	14,900.00	1,120.00	1,410.00	4,950.00
MANGANESE	668.00	3.90E+02	359.00	53.40	759.00	98.40	774.00	58.10	63.80	216.00
NICKEL	24.90	1.60E+03	16.60	4.30	25.80	5.30	28.20	3.30	5.00	11.90
POTASSIUM	7,660.00		4,050.00	688.00	6,470.00	1,020.00	6,950.00	722.00	918.00	3,360.00
SILVER	ND	3.90E+02	ND	ND	ND	ND	ND	ND	ND	ND
SODIUM	1,270.00		775.00	225.00	877.00	115.00	828.00	173.00	136.00	181.00
THALLIUM	1.20		1.5 (N)	0.43 (N)	2.1 (N)	0.44 (N)	2.5 (N)	0.51 (N)	0.47 (N)	0.67 (N)
VANADIUM	66.10	5.50E+02	43.40	7.30	65.60	14.00	71.80	7.40	8.60	27.10
ZINC	131.00	2.30E+04	73.20	10.50	100.00	15.40	107.00	10.70	12.30	51.10
NITROGEN										
TKN	2,200.00		81.00	1.50	100.00	ND	130.00	ND	ND	1,450.00
AMMONIA	56.20		5.10	2.50	64.00	1.40	71.00	ND	1.10	50.00
NITRATE/NITRITE	0.80	1.00E+05	ND	1.40	ND	4.80	129.00	7.00	8.70	0.65

TABLE 7-9
Analytes Detected in Soil--Site 16
Metals and Nitrogen
NWS Seal Beach, Seal Beach, California
(Sheet 2 of 4)

ANALYTE	BACKGROUND 16H014A0-1 (mg/kg)	PRG (mg/kg)	SAMPLE NUMBERS 16H004A0-2 (mg/kg)	16H005A0-1 (mg/kg)	16H005A0-2 (mg/kg)	16H005A1-1 (mg/kg)	16H006A0-1 (mg/kg)	16H006A0-2 (mg/kg)	16H006A1-2 (mg/kg)	16H007A0-1 (mg/kg)
METALS										
ALUMINUM	26,400.00	7.80E+04	17,700.00	5,600.00	7,470.00	4,950.00	6980 (*)	9830 (*)	14500 (*)	4,230.00
ARSENIC	1.90	9.70E-01	3.2 (N)	2.4 (N)	2.5 (N)	2.1 (N)	2 (N)	3.4 (N)	5.1 (N)	1.20
BARIUM	143.00	5.50E+03	107.00	38.00	49.70	32.70	49 (*)	78.6 (*)	124 (*)	20.80
BERYLLIUM	0.94	4.00E-01	ND	ND	ND	ND	ND	ND	ND	ND
CADMIUM	ND	3.90E+01	0.84	ND	0.79	1.20	1.00	ND	ND	0.83
CALCIUM	14,300.00		40,100.00	7,260.00	8,640.00	19,000.00	4670 (*)	7940 (*)	6830 (*)	8,240.00
CHROMIUM	31.80	3.90E+02	19.60	8.10	10.10	9.60	10.8 (*)	13.3 (*)	20.9 (*)	6.50
COBALT	12.40		10.00	4.90	5.30	4.00	5.3 (*)	7.2 (*)	9.6 (*)	2.40
COPPER	30.60	2.90E+03	19.60	9.20	10.50	12.70	12.4 (*)	11.9 (*)	18.6 (*)	8.10
IRON	33,400.00		24,200.00	10,600.00	12,100.00	13,300.00	13000 (*)	15400 (*)	24700 (*)	9,330.00
LEAD	9.30	5.00E+02	17.2 (N)	6.9 (N)	4.6 (N)	14.5 (N)	25.2 (*,N)	4.5 (*,N)	5.5 (*,N)	4.10
MAGNESIUM	15,800.00		13,500.00	2,960.00	3,880.00	2,480.00	3950 (*)	5680 (*)	8790 (*)	2,000.00
MANGANESE	668.00	3.90E+02	607.00	136.00	164.00	151.00	198 (*,N)	206 (*,N)	323 (*,N)	98.70
NICKEL	24.90	1.60E+03	16.30	7.10	10.10	9.10	9.9 (*)	12.2 (*)	20.9 (*)	5.80
POTASSIUM	7,660.00		5,750.00	1,980.00	2,470.00	1,850.00	2740 (*)	3630 (*)	5760 (*)	1,080.00
SILVER	ND	3.90E+02	ND	ND	ND	ND	1.50	ND	ND	ND
SODIUM	1,270.00		1,460.00	146.00	170.00	239.00	292.00	1,320.00	1,510.00	177.00
THALLIUM	1.20		1.6 (N)	0.53 (N)	0.54 (N)	0.85 (N)	ND	ND	0.87	0.36
VANADIUM	66.10	5.50E+02	45.20	18.60	21.20	16.90	23.7 (*)	28.8 (*)	46 (*)	20.60
ZINC	131.00	2.30E+04	74.60	37.10	38.60	67.10	242 (*)	51.8 (*)	66.4 (*)	45.80
NITROGEN										
TKN	2,200.00		1,700.00	1,100.00	300.00	2,500.00	245.00	98.70	41.40	94.30
AMMONIA	56.20		42.00	12.00	12.00	38.00	29.30	4.79	5.21	7.41
NITRATE/NITRITE	0.80	1.00E+05	0.20	0.33	0.32	0.57	ND	0.31	0.13	2.17

TABLE 7-9
Analytes Detected in Soil--Site 16
Metals and Nitrogen
NWS Seal Beach, Seal Beach, California
(Sheet 3 of 4)

ANALYTE	BACKGROUND 16H014A0-1 (mg/kg)	PRG (mg/kg)	SAMPLE NUMBERS 16H007A0-2 (mg/kg)	16H008A0-1 (mg/kg)	16H008A0-2 (mg/kg)	16H009A0-1 (mg/kg)	16H009A0-2 (mg/kg)	16H010A0-1 (mg/kg)	16H010A0-2 (mg/kg)	16H011A0-1 (mg/kg)
METALS										
ALUMINUM	26,400.00	7.80E+04	4,050.00	6250 (*)	7210 (*)	11000 (*)	15100 (*)	4890 (*)	4710 (*)	27,600.00
ARSENIC	1.90	9.70E-01	0.95	1.6 (N)	2.6 (N)	2.8 (N)	6.7 (N)	1 (N)	1.3 (N)	4.20
BARIUM	143.00	5.50E+03	20.90	47.7 (*)	60.8 (*)	79.8 (*)	106 (*)	33.6 (*)	31.5 (*)	132.00
BERYLLIUM	0.94	4.00E-01	ND	ND	ND	ND	ND	ND	ND	ND
CADMIUM	ND	3.90E+01	ND	ND	ND	ND	ND	ND	ND	ND
CALCIUM	14,300.00		7,550.00	4280 (*)	3990 (*)	6350 (*)	9060 (*)	3910 (*)	3960 (*)	17,900.00
CHROMIUM	31.80	3.90E+02	5.90	9.5 (*)	10.5 (*)	15.9 (*)	20.1 (*)	7.1 (*)	7 (*)	30.50
COBALT	12.40		2.20	4.6 (*)	5.5 (*)	8.2 (*)	9 (*)	3.7 (*)	3.7 (*)	13.00
COPPER	30.60	2.90E+03	7.50	9.1 (*)	9.5 (*)	17.1 (*)	17.2 (*)	6.4 (*)	5.7 (*)	27.10
IRON	33,400.00		8,330.00	11200 (*)	11900 (*)	18000 (*)	23200 (*)	9430 (*)	8670 (*)	32,900.00
LEAD	9.30	5.00E+02	4.30	6.7 (*,N)	3.8 (*,N)	9.3 (*,N)	5.5 (*,N)	4.7 (*,N)	2.6 (*,N)	6.70
MAGNESIUM	15,800.00		1,980.00	3850 (*)	4420 (*)	6250 (*)	8250 (*)	2820 (*)	2790 (*)	13,400.00
MANGANESE	668.00	3.90E+02	94.10	163 (*,N)	167 (*,N)	272 (*,N)	342 (*,N)	127 (*,N)	119 (*,N)	554.00
NICKEL	24.90	1.60E+03	5.30	9.6 (*)	10.8 (*)	15.9 (*)	16.7 (*)	6.1 (*)	6 (*)	22.50
POTASSIUM	7,660.00		945.00	2430 (*)	2660 (*)	4630 (*)	5100 (*)	1650 (*)	1560 (*)	7,210.00
SILVER	ND	3.90E+02	ND	ND	ND	ND	ND	ND	ND	ND
SODIUM	1,270.00		148.00	316.00	1,030.00	378.00	1,850.00	250.00	223.00	6,000.00
THALLIUM	1.20		0.32	ND	0.71	ND	ND	ND	ND	1.30
VANADIUM	66.10	5.50E+02	17.50	21.2 (*)	22 (*)	35.6 (*)	45.6 (*)	18.6 (*)	17.1 (*)	70.70
ZINC	131.00	2.30E+04	45.30	64.9 (*)	35.9 (*)	67.8 (*)	61.4 (*)	26 (*)	21.6 (*)	87.40
NITROGEN										
TKN	2,200.00		460.00	257.00	37.10	284.00	33.90	290.00	200.00	793.00
AMMONIA	56.20		9.16	19.70	36.00	19.20	9.16	25.10	10.30	7.89
NITRATE/NITRITE	0.80	1.00E+05	2.03	2.47	0.36	7.57	0.46	0.49	0.33	ND

TABLE 7-9
Analytes Detected in Soil--Site 16
Metals and Nitrogen
NWS Seal Beach, Seal Beach, California
(Sheet 4 of 4)

ANALYTE	BACKGROUND 16H014A0-1 (mg/kg)	PRG (mg/kg)	SAMPLE NUMBERS 16H011A0-2 (mg/kg)	16H012A0-1 (mg/kg)	16H012A0-2 (mg/kg)	16H013A0-1 (mg/kg)	16H013A0-2 (mg/kg)
METALS							
ALUMINUM	26,400.00	7.80E+04	9,460.00	22,700.00	8,580.00	11,400.00	11,400.00
ARSENIC	1.90	9.70E-01	ND	5.90	1.10	2.1 (N)	2.2 (N)
BARIUM	143.00	5.50E+03	42.50	110.00	41.70	111.00	123.00
BERYLLIUM	0.94	4.00E-01	ND	ND	ND	ND	ND
CADMIUM	ND	3.90E+01	ND	ND	ND	ND	ND
CALCIUM	14,300.00		8,460.00	12,200.00	5,390.00	20,900.00	17,100.00
CHROMIUM	31.80	3.90E+02	13.00	27.40	12.80	15.60	17.30
COBALT	12.40		5.30	11.00	5.70	6.70	6.20
COPPER	30.60	2.90E+03	7.40	23.80	6.10	14.30	16.50
IRON	33,400.00		16,800.00	29,000.00	15,800.00	15,800.00	15,300.00
LEAD	9.30	5.00E+02	1.70	5.80	1.70	3.6 (N)	4.1 (N)
MAGNESIUM	15,800.00		5,670.00	11,800.00	5,440.00	4,980.00	4,170.00
MANGANESE	668.00	3.90E+02	255.00	444.00	243.00	198.00	147.00
NICKEL	24.90	1.60E+03	9.40	19.40	7.20	12.50	11.90
POTASSIUM	7,660.00		2,830.00	6,520.00	2,970.00	2,950.00	4,300.00
SILVER	ND	3.90E+02	ND	ND	ND	ND	ND
SODIUM	1,270.00		3,090.00	6,260.00	3,470.00	1,950.00	699.00
THALLIUM	1.20		0.74	1.02	0.53	0.68 (N)	0.8 (N)
VANADIUM	66.10	5.50E+02	34.50	62.60	31.80	27.80	24.90
ZINC	131.00	2.30E+04	37.30	84.20	37.40	48.20	60.20
NITROGEN							
TKN	2,200.00		268.00	1,030.00	138.00	83.00	109.00
AMMONIA	56.20		4.27	8.65	2.44	2.00	2.30
NITRATE/NITRITE	0.80	1.00E+05	ND	ND	ND	13.70	4.20

Shaded concentrations indicate the value is above the background screening level (see text Section 5.4), except those analytes detected in the method blanks.

Not all analytes tested for are listed; those not listed were not detected (ND). For a complete list of analytes requested and tested, see Appendix C.

* -- Duplicate analysis not within control limits.

N -- Spiked sample, recovery not within control limits.

PRG -- Preliminary remediation goal, 4th quarter, 1993, residential soil classification.

TABLE 7-10
Analytes Detected in Soil--Site 16
Volatile and Semivolatile Organics
NWS Seal Beach, Seal Beach, California
(Sheet 1 of 4)

ANALYTE	BACKGROUND 16H014A0-1 (ug/kg)	PRG (ug/kg)	SAMPLE NUMBERS 16H001A0-1 (ug/kg)	16H001A0-2 (ug/kg)	16H002A0-1 (ug/kg)	16H002A0-2 (ug/kg)	16H003A0-1 (ug/kg)	16H003A0-2 (ug/kg)	16H003A1-2 (ug/kg)	16H004A0-1 (ug/kg)
SEMIVOLATILE ORGANICS										
BIS(2-ETHYLHEXYL)PHTHALATE	22(B)	6.10E+04	24.00	17.00	13.00	31.00	26.00	18.00	14.00	26.00
BUTYLBENZYLPHTHALATE	ND	7.80E+06	ND	ND	ND	ND	ND	11.00	ND	16.00
DI-N-BUTYLPHTHALATE	194(B)		417.00	287.00	2679.00	1655.00	2531.00	284.00	170.00	185.00
DIETHYLPHTHALATE	ND	3.10E+07	ND	20.00	ND	19.00	ND	19.00	10.00	28.00
PYRENE	ND	1.20E+06	61.00	ND	ND	ND	ND	ND	ND	ND
VOLATILE ORGANICS										
ACETONE	ND	9.20E+06	ND	ND	222.00	ND	ND	ND	ND	ND
TOLUENE	ND	2.80E+05	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROFLUOROMETHANE	ND	4.10E+05	ND	ND	ND	ND	ND	ND	ND	ND

TABLE 7-10
Analytes Detected in Soil--Site 16
Volatile and Semivolatile Organics
NWS Seal Beach, Seal Beach, California
(Sheet 2 of 4)

ANALYTE	BACKGROUND	PRG	SAMPLE NUMBERS							
	16H014A0-1 (ug/kg)	(ug/kg)	16H004A0-2 (ug/kg)	16H005A0-1 (ug/kg)	16H005A0-2 (ug/kg)	16H005A1-1 (ug/kg)	16H006A0-1 (ug/kg)	16H006A0-2 (ug/kg)	16H006A1-2 (ug/kg)	16H007A0-1 (ug/kg)
SEMIVOLATILE ORGANICS										
BIS(2-ETHYLHEXYL)PHTHALATE	22(B)	6.10E+04	21.00	12.00	11.00	38.00	ND	ND	ND	17(B)
BUTYLBENZYLPHTHALATE	ND	7.80E+06	ND	ND	ND	ND	ND	ND	ND	ND
DI-N-BUTYLPHTHALATE	194(B)		195.00	149.00	159.00	1572.00	294(B)	386(B)	297(B)	163(B)
DIETHYLPHTHALATE	ND	3.10E+07	21.00	20.00	11.00	10.00	ND	ND	ND	ND
PYRENE	ND	1.20E+06	ND	ND	ND	ND	ND	ND	ND	10.00
VOLATILE ORGANICS										
ACETONE	ND	9.20E+06	ND	ND	ND	ND	ND	ND	ND	ND
TOLUENE	ND	2.80E+05	ND	ND	ND	ND	ND	1.00	ND	ND
TRICHLOROFLUOROMETHANE	ND	4.10E+05	ND	ND	ND	ND	ND	ND	2.00	ND

TABLE 7-10
Analytes Detected in Soil--Site 16
Volatile and Semivolatile Organics
NWS Seal Beach, Seal Beach, California
(Sheet 3 of 4)

ANALYTE	BACKGROUND 16H014A0-1 (ug/kg)	PRG (ug/kg)	SAMPLE NUMBERS 16H007A0-2 (ug/kg)	16H008A0-1 (ug/kg)	16H008A0-2 (ug/kg)	16H009A0-1 (ug/kg)	16H009A0-2 (ug/kg)	16H010A0-1 (ug/kg)	16H010A0-2 (ug/kg)	16H011A0-1 (ug/kg)
SEMIVOLATILE ORGANICS										
BIS(2-ETHYLHEXYL)PHTHALATE	22(B)	6.10E+04	28(B)	ND	ND	ND	ND	ND	ND	13(B)
BUTYLBENZYLPHTHALATE	ND	7.80E+06	7.00	ND	ND	ND	ND	ND	ND	ND
DI-N-BUTYLPHTHALATE	194(B)		319(B)	373(B)	346(B)	300(B)	230(B)	222(B)	352(B)	163(B)
DIETHYLPHTHALATE	ND	3.10E+07	ND	ND	ND	ND	ND	ND	ND	ND
PYRENE	ND	1.20E+06	ND	ND	ND	ND	ND	ND	ND	ND
VOLATILE ORGANICS										
ACETONE	ND	9.20E+06	ND	ND	ND	ND	ND	ND	ND	ND
TOLUENE	ND	2.80E+05	ND	0.00	ND	ND	ND	ND	ND	ND
TRICHLOROFLUOROMETHANE	ND	4.10E+05	ND	3.00	ND	ND	3.00	ND	ND	ND

TABLE 7-10
Analytes Detected in Soil--Site 16
Volatile and Semivolatile Organics
NWS Seal Beach, Seal Beach, California
(Sheet 4 of 4)

ANALYTE	BACKGROUND 16H014A0-1 (ug/kg)	PRG (ug/kg)	SAMPLE NUMBERS 16H011A0-2 (ug/kg)	16H012A0-1 (ug/kg)	16H012A0-2 (ug/kg)	16H013A0-1 (ug/kg)	16H013A0-2 (ug/kg)
SEMIVOLATILE ORGANICS							
BIS(2-ETHYLHEXYL)PHTHALATE	22(B)	6.10E+04	18(B)	19(B)	15(B)	26.00	15.00
BUTYLBENZYLPHTHALATE	ND	7.80E+06	ND	ND	ND	ND	ND
DI-N-BUTYLPHTHALATE	194(B)		408(B)	243(B)	166(B)	488.00	205.00
DIETHYLPHTHALATE	ND	3.10E+07	ND	ND	ND	20.00	18.00
PYRENE	ND	1.20E+06	ND	ND	ND	ND	ND
VOLATILE ORGANICS							
ACETONE	ND	9.20E+06	ND	ND	ND	ND	ND
TOLUENE	ND	2.80E+05	ND	ND	ND	ND	ND
TRICHLOROFLUOROMETHANE	ND	4.10E+05	3.00	ND	ND	ND	ND

Shaded concentrations indicate the value is above the background screening level (see text Section 5.4), except those analytes detected in the method blanks.

Not all analytes tested for are listed; those not listed were not detected (ND). For a complete list of analytes requested and tested, see Appendix C.

B -- Analyte is found in the associated blank as well as in the sample.

PRG -- Preliminary remediation goal, 4th quarter, 1993, residential soil classification.

TABLE 7-11
Analytes Detected In Groundwater - Site 16
NWS Seal Beach, California
(Sheet 1 of 2)

ANALYTE	MCL (EPA) (µg/l)	MCL (DHS) (µg/l)	16GP01A0-1 (µg/l)	Q	16GP02A0-1 (µg/l)	Q	16GP02A1-1 (µg/l)	Q	16GP03A0-1 (µg/l)	Q
METALS										
ALUMINUM		1,000.00	144.00	B	271.00		483.00		319.00	
ANTIMONY	6.00		62.70		ND		78.70		ND	
BARIUM	2,000.00	1,000.00	481.00		193.00		190.00		101.00	
CALCIUM			464,000.00		1,350,000.00		1,350,000.00		34,100.00	
COBALT			ND		15.70		22.60		ND	
IRON			140.00		20,900.00		21,500.00		218.00	
LEAD		50.00	ND		0.50		ND		ND	
MAGNESIUM			691,000.00		1,150,000.00		1,170,000.00		13,400.00	
MANGANESE			3,170.00		10,900.00		10,400.00		402.00	
NICKEL	100.00		ND		22.30	B	58.50		ND	
POTASSIUM			162,000.00		133,000.00		131,000.00		11,800.00	
SODIUM			4,890,000.00		9,220,000.00		9,390,000.00		354,000.00	
THALLIUM	2.00		ND		4.90	B	5.70	B	ND	
ZINC			8,490.00		15,900.00		14,500.00		215.00	
GENERAL CHEMISTRY										
AMMONIA (as N)			1,720.00		1,860.00		1,790.00		ND	
TKN			1,450.00		1,940.00		1,580.00		ND	
VOLATILE ORGANICS										
METHYLENE CHLORIDE	5.00		ND		ND		4.00	JB	3.00	JB

TABLE 7-11
Analytes Detected in Groundwater - Site 16
NWS Seal Beach, California
(Sheet 2 of 2)

Not all analytes tested for are listed. Those not listed were not detected (ND).
For a complete list of analytes requested and tested for, see Table 5-4 and Appendix C.
Shaded concentrations indicate the value is above an MCL, except for values that have a "B" qualifier.

EPA - Environmental Protection Agency.
DHS - California Department of Health Services.
MCL - Maximum contaminant level.

Q - Qualifier.
B - Analyte is found in the associated blank as well as in the sample.
E - Concentration exceeds the calibration range of the GC/MS instrument.
N - Indicates presumptive evidence of a compound.
J - Indicates an estimated value, less than the CRQL and greater than zero.

TABLE 7-13
Analytes Detected in Soil--Site 42
Metals, Oil and Grease, and Pesticides/PCBs
NWS Seal Beach, Seal Beach, California

ANALYTE	BACKGROUND 42H008A0-1 (mg/kg)	BACKGROUND 42H009A0-1 (mg/kg)	PRG (mg/kg)	SAMPLE NUMBERS 42A005A0-1 (mg/kg)	42A005A0-2 (mg/kg)	42A006A0-1 (mg/kg)	42A006A0-2 (mg/kg)	42H001A0-1 (mg/kg)	42H002A0-1 (mg/kg)	42H003A0-1 (mg/kg)	42H003A1-1 (mg/kg)	42H004A0-1 (mg/kg)	42H007A0-1 (mg/kg)
METALS													
ALUMINUM	10,300.00	30,000.00	7.80E+03	NA	12,300.00	NA	12,900.00	11,600.00	15,100.00	5,400.00	6,260.00	7,960.00	14,300.00
ARSENIC	1.30	4.10	9.70E-01	NA	ND	NA	1.8 (N)	5.50	3.30	0.79	1.30	5.20	2.40
BARIUM	54.10	123.00	5.50E+03	NA	79.00	NA	108.00	81.50	102.00	23.80	41.40	82.50	78.30
BERYLLIUM	ND	1.10	4.00E-01	NA	ND	NA	ND	ND	ND	ND	ND	ND	ND
CADMIUM	ND	ND	3.90E+01	NA	ND	NA	ND	0.76	0.90	ND	ND	5.30	ND
CALCIUM	2,150.00	10,900.00		NA	3,660.00	NA	46,400.00	2,290.00	2,020.00	2,460.00	2,760.00	4,720.00	2,430.00
CHROMIUM	18.10	32.00	3.90E+02	NA	16.50	NA	16.00	20.30	23.40	9.40	9.60	28.90	17.10
COBALT	9.10	10.30		NA	7.70	NA	7.50	11.10	9.30	2.20	3.50	6.10	7.30
COPPER	10.40	18.60	2.90E+03	NA	12.50	NA	11.00	15.00	14.80	4.80	6.10	48.70	12.40
IRON	15,800.00	32,300.00		NA	17,800.00	NA	17,000.00	18,400.00	21,900.00	7,170.00	9,330.00	14,500.00	17,000.00
LEAD	4.00 (N)	5.90	5.00E+02	NA	11.6 (N)	NA	8.7 (N)	5.40	5.60	1.6 (N)	2.1 (N)	255.00	4.2 (N)
MAGNESIUM	3,880.00	9,050.00		NA	4,640.00	NA	7,060.00	4,800.00	6,100.00	2,410.00	3,350.00	4,200.00	4,330.00
MANGANESE	757.00	269.00	3.90E+02	NA	376.00	NA	309.00	541.00	380.00	96.60	127.00	199.00	319.00
MERCURY	ND	0.29	2.30E+02	NA	ND	NA	ND	ND	ND	ND	0.14	0.68	ND
NICKEL	10.50	22.90	1.60E+03	NA	11.40	NA	13.90	13.10	15.80	6.40	7.20	20.10	13.10
POTASSIUM	3,400.00	4,960.00		NA	3,870.00	NA	2,730.00	3,100.00	3,930.00	1,440.00	2,180.00	2,170.00	3,180.00
SILVER	ND	ND	3.90E+02	NA	ND	NA	ND	ND	ND	3.10	ND	1.60	ND
SODIUM	675.00	1,610.00		NA	443.00	NA	1,320.00	1,090.00	2,330.00	191.00	204.00	277.00	426.00
THALLIUM	1.00 (N)	1.02		NA	0.87 (N)	NA	1.1 (N)	1.00	1.10	0.46 (N)	0.75 (N)	1.00	1.2 (N)
VANADIUM	35.90	60.40	5.50E+02	NA	33.60	NA	27.70	40.90	44.00	14.60	18.60	28.70	34.90
ZINC	33.80	67.00	2.30E+04	NA	42.40	NA	44.40	41.60	53.40	25.60	29.40	198.00	41.40
GENERAL CHEMISTRY													
OIL AND GREASE	ND	ND		ND	18.00	88.00	88.00	17.00	17.00	12.00	11.00	270.00	ND
PESTICIDES													
4,4'-DDE	ND	ND	2.50E+00	NA	ND	NA	0.0003	ND	ND	ND	ND	ND	ND
AROCLOR-1260	ND	ND		NA	ND	NA	ND	ND	ND	ND	ND	0.06	ND

Shaded concentrations indicate the value is above the background screening level (see text Section 5.4), except those analytes detected in the method blanks.

Not all analytes tested for are listed; those not listed were not detected (ND). For a complete list of analytes requested and tested, see Appendix C.

* -- Duplicate analysis not within control limit.

NA -- Not analyzed.

N -- Spiked sample, recovery not within control limits.

PRG -- Preliminary remediation goal, 4th quarter, 1993, residential soil classification.

TABLE 7-14
Analytes Detected in Soil--Site 42
Volatile and Semivolatile Organics
NWS Seal Beach, Seal Beach, California

ANALYTE	BACKGROUND 42H008A0-1 (ug/kg)	BACKGROUND 42H009A0-1 (ug/kg)	PRG (ug/kg)	SAMPLE NUMBERS 42A005A0-2 (ug/kg)	42A006A0-2 (ug/kg)	42H001A0-1 (ug/kg)	42H002A0-1 (ug/kg)	42H003A0-1 (ug/kg)	42H003A1-1 (ug/kg)	42H004A0-1 (ug/kg)	42H007A0-1 (ug/kg)
SEMIVOLATILE ORGANICS											
2-METHYLNAPHTHALENE	ND	ND		ND	ND	ND	ND	ND	ND	16.00	ND
ACENAPHTHENE	ND	ND		ND	ND	ND	ND	ND	ND	5.00	ND
BENZO(A)PYRENE	ND	ND		ND	ND	ND	ND	ND	ND	46.00	ND
BIS(2-ETHYLHEXYL)PHTHALATE	117(B)	17(B)	6.10E+04	14.00	17.00	899(B)	1457(B)	249(B)	58(B)	1044(B)	22(B)
BUTYLBENZYLPHTHALATE	ND	ND	7.80E+06	ND	7.00	1053(B)	1281(B)	1116(B)	ND	534(B)	ND
CHRYSENE	ND	ND		ND	ND	ND	ND	ND	ND	84.00	ND
DIETHYLPHTHALATE	ND	ND	3.10E+07	ND	16.00	ND	ND	ND	ND	ND	ND
DI-N-BUTYLPHTHALATE	807(B)	176(B)		239.00	318.00	4315(B)	4033(B)	ND	732(B)	3178(B)	827(B)
FLUORANTHENE	ND	ND		ND	ND	ND	ND	ND	ND	53.00	ND
N-NITROSODIPHENYLAMINE	ND	ND	1.70E+05	ND	ND	ND	ND	ND	ND	25.00	ND
PHENANTHRENE	ND	ND		ND	ND	ND	ND	ND	ND	26.00	ND
PYRENE	ND	ND	1.20E+06	ND	6.00	ND	ND	ND	ND	133.00	ND
VOLATILE ORGANICS											
ACETONE	ND	ND	9.20E+06	ND	ND	ND	ND	26.00	ND	ND	ND
ETHYLBENZENE	ND	ND	3.10E+05	ND	ND	ND	ND	ND	ND	ND	6.00
XYLENES	ND	ND	9.90E+04	ND	ND	ND	ND	ND	ND	ND	42.00

Shaded concentrations indicate the value is above the background screening level (see text Section 5.4), except those analytes detected in the method blanks.

Not all analytes tested for are listed; those not listed were not detected (ND). For a complete list of analytes requested and tested, see Appendix C.

B -- Analyte is found in the associated blank as well as in the sample.

PRG -- Preliminary remediation goal, 4th quarter, 1993, residential soil classification.

TABLE 7-15
Analytes Detected In Groundwater - Site 42
NWS Seal Beach, California

ANALYTE	MCL (EPA) (µg/l)	MCL (DHS) (µg/l)	42GB13A0-1 (µg/l)	Q	42GB13A1-1 (µg/l)	Q
METALS						
ALUMINUM		1,000.00	599.00		600.00	
BARIUM	2,000.00	1,000.00	15.30	B	17.60	B
CALCIUM			14,900.00	E	15,900.00	E
IRON			478.00		464.00	
MAGNESIUM			9,380.00		9,290.00	
SODIUM			296,000.00		301,000.00	
GENERAL CHEMISTRY						
OIL AND GREASE			2,000.00		2,000.00	

Not all analytes tested for are listed. Those not listed were not detected (ND).
For a complete list of analytes requested and tested for, see Table 5-4 and Appendix C.

EPA - Environmental Protection Agency.
DHS - California Department of Health Services.
MCL - Maximum contaminant level.

Q - Qualifier.
B - Analytes is found in the associated blank as well as in the sample.
E - Concentration exceeds the calibration range of the gas chromatography/mass spectroscopy (GC/MS) instrument.

TABLE 7-17
Analytes Detected in Soil–Site 43
Metals, Oil and Grease, and pH
NWS Seal Beach, Seal Beach, California

ANALYTE	BACKGROUND 42H008A0-1 (mg/kg)	BACKGROUND 42H009A0-1 (mg/kg)	PRG (mg/kg)	SAMPLE NUMBERS 43H001A0-1 (mg/kg)	43H001A1-1 (mg/kg)	43H002A0-1 (mg/kg)	43H003A0-1 (mg/kg)	43H004A0-1 (mg/kg)	43H005A0-1 (mg/kg)	43H006A0-1 (mg/kg)	43H007A0-1 (mg/kg)	43H007A1-1 (mg/kg)	43H008A0-1 (mg/kg)
METALS													
ALUMINUM	10,300.00	30,000.00	7.80E+04	22,800.00	21,100.00	14,200.00	9,700.00	16,700.00	15,400.00	11,800.00	26,500.00	26,400.00	25,200.00
ARSENIC	1.30	4.10	9.70E-01	3.10	5.1 (*)	2.80	0.56	2.80	2.60	2.30	5.20	3.00	2.8 (*)
BARIUM	54.10	123.00	5.50E+03	139.00	106.00	91.00	56.50	84.80	66.20	68.20	138.00	133.00	77.70
BERYLLIUM	ND	1.10	4.00E-01	1.00	0.93	ND	ND	0.82	ND	ND	1.00	1.10	1.10
CALCIUM	2,150.00	10,900.00		1,930.00	25,000.00	2,230.00	2,170.00	2,080.00	1,670.00	2,110.00	9,420.00	2,080.00	3,690.00
CHROMIUM	18.10	32.00	3.90E+02	29.90	25.70	21.70	16.50	23.80	21.00	19.70	29.90	28.50	28.20
COBALT	9.10	10.30		10.60	9.90	8.60	6.40	8.70	9.30	7.60	11.00	12.10	12.60
COPPER	10.40	18.60	2.90E+03	20.00	17.60	15.20	11.70	17.70	12.40	14.90	19.00	20.50	19.70
IRON	15,800.00	32,300.00		29,400.00	25,900.00	19,600.00	15,400.00	22,300.00	21,000.00	17,000.00	28,700.00	29,400.00	30,500.00
LEAD	4.00	5.90	5.00E+02	6.40	5.50	5 (N)	3.5 (N)	4.9 (N)	5.30	4.9 (N)	6.3 (N)	6.5 (N)	6.40
MAGNESIUM	3,880.00	9,050.00		6,920.00	6,810.00	4,750.00	4,530.00	6,160.00	5,670.00	4,520.00	7,140.00	6,930.00	7,270.00
MANGANESE	757.00	269.00	3.90E+02	467.00	867.00	374.00	401.00	473.00	446.00	334.00	608.00	641.00	663.00
MERCURY	ND	0.29	2.30E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NICKEL	10.50	22.90	1.60E+03	22.50	20.00	14.60	11.90	21.40	16.50	14.00	25.10	22.10	23.10
POTASSIUM	3,400.00	4,960.00		3,930.00	3,650.00	3,530.00	3,850.00	3,910.00	3,010.00	3,790.00	4,150.00	4,340.00	4,730.00
SODIUM	675.00	1,610.00		2,780.00	2,860.00	1,860.00	1,350.00	3,110.00	1,670.00	1,440.00	3,210.00	3,140.00	3,710.00
THALLIUM	1.00	1.02		1.40	1.50	1.1 (N)	0.89 (N)	1.2 (N)	1.10	1.1 (N)	1.5 (N)	1.5 (N)	1.4 (N)
VANADIUM	35.90	60.40	5.50E+02	58.70	52.50	40.50	30.60	45.40	43.60	37.30	59.80	60.10	60.60
ZINC	33.80	67.00	2.30E+04	62.80	56.10	44.40	37.30	52.90	47.80	41.60	62.50	63.80	66.10
GENERAL CHEMISTRY													
OIL AND GREASE	ND	ND		1,200.00	860.00	12.00	ND	ND	ND	33.00	ND	ND	ND
pH	NA	NA		9.10	9.00	8.80	9.00	9.20	9.10	8.50	8.80	8.70	8.90

Shaded concentrations indicate the value is above the background screening level (see text Section 5.4), except those analytes detected in the method blanks.

Not all analytes tested for are listed; those not listed were not detected (ND). For a complete list of analytes requested and tested, see Appendix C.

N -- Spiked sample, recovery not within control limits.

PRG -- Preliminary remediation goal, 4th quarter, 1993, residential soil classification.

TABLE 7-18
Analytes Detected in Soil--Site 43
Volatile and Semivolatile Organics
NWS Seal Beach, Seal Beach, California

ANALYTE	BACKGROUND 42H008A0-1 (ug/kg)	BACKGROUND 42H009A0-1 (ug/kg)	PRG (ug/kg)	SAMPLER NUMBERS 43H001A0-1 (ug/kg)	43H001A1-1 (ug/kg)	43H002A0-1 (ug/kg)	43H003A0-1 (ug/kg)	43H004A0-1 (ug/kg)	43H005A0-1 (ug/kg)	43H006A0-1 (ug/kg)	43H007A0-1 (ug/kg)	43H007A1-1 (ug/kg)	43H008A0-1 (ug/kg)
SEMIVOLATILE ORGANICS													
2-METHYLNAPHTHALENE	ND	ND		3,091.00	2,822.00	ND	ND	ND	ND	ND	ND	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	117(B)	17(B)	6.10E+04	28(B)	35(B)	16(B)	22(B)	28(B)	2738(B)	15(B)	49(B)	56(B)	24(B)
BUTYLBENZYLPHTHALATE	ND	ND	7.80E+06	ND	ND	ND	56.00	ND	1735(B)	ND	ND	ND	19.00
DI-N-BUTYLPHTHALATE	807(B)	176(B)		209(B)	349(B)	1156(B)	175(B)	2520(B)	3354(B)	921(B)	323(B)	489(B)	232(B)
NAPHTHALENE	ND	ND		1,136.00	1,898.00	ND	ND	ND	ND	ND	ND	ND	ND
VOLATILE ORGANICS													
2-BUTANONE	ND	ND	5.20E+06	ND	ND	35.00	ND	ND	ND	ND	ND	ND	ND
ACETONE	ND	ND	9.20E+06	ND	ND	156.00	ND	ND	ND	41.00	ND	ND	ND
TETRACHLOROETHENE	ND	ND	2.20E+04	ND	ND	ND	32.00	ND	ND	ND	ND	ND	ND

Shaded concentrations indicate the value is above the background screening level (see text Section 5.4), except those analytes detected in the method blanks.
Not all analytes tested for are listed; those not listed were not detected (ND). For a complete list of analytes requested and tested, see Appendix C.
B -- Analyte is found in the associated blank as well as in the sample.
PRG -- Preliminary remediation goal, 4th quarter, 1993, residential soil classification.

TABLE 7-20
Analytes Detected in Soil--Sites 44 and 45
Metals
NWS Seal Beach, Seal Beach, California

ANALYTE	BACKGROUND 45H004A0-1 (mg/kg)	PRG (mg/kg)	SAMPLE NUMBERS 44H001A0-1 (mg/kg)	44H002A0-1 (mg/kg)	45H001A0-1 (mg/kg)	45H001A0-2 (mg/kg)	45H001A1-2 (mg/kg)	45H002A0-1 (mg/kg)	45H002A0-2 (mg/kg)	45H003A0-1 (mg/kg)
METALS										
ALUMINUM	41,500.00	7.80E+04	8,390.00	8,860.00	9,760.00	22,000.00	21,900.00	12,600.00	17,500.00	5,600.00
ARSENIC	2.50	9.70E-01	2.5 (*)	1.60	6.7 (*)	14.2 (*)	8.9 (*)	5.9 (*)	11 (*)	0.49 (*)
BARIUM	119.00	5.50E+03	52.50	55.20	102.00	135.00	105.00	193.00	128.00	32.80
BERYLLIUM	1.50	4.00E-01	ND	ND	ND	0.90	0.93	ND	ND	ND
CADMIUM	ND	3.90E+01	ND	ND	ND	0.96	ND	0.88	0.90	ND
CALCIUM	11,200.00		4,130.00	6510 (*)	7,310.00	31,100.00	22,000.00	18,000.00	32,600.00	3,440.00
CHROMIUM	43.40	3.90E+02	13.00	19.60	30.10	28.70	28.80	38.70	23.10	13.40
COBALT	17.20		4.30	5.30	6.10	10.70	10.40	7.40	10.90	2.90
COPPER	41.80	2.90E+03	10.70	14 (*)	26.80	32.80	32.20	36.50	21.80	5.90
IRON	46,500.00		13,300.00	13,000.00	16,100.00	30,700.00	31,900.00	19,500.00	26,600.00	9,420.00
LEAD	12.10	5.00E+02	3.80	3.6 (*)	22.80	7.70	8.00	32.80	5.90	2.30
MAGNESIUM	17,300.00		3,860.00	4,990.00	5,830.00	12,200.00	12,200.00	6,600.00	10,400.00	2,750.00
MANGANESE	1,350.00	3.90E+02	170.00	203 (N)	230.00	583.00	456.00	299.00	575.00	132.00
MERCURY	ND	2.30E+02	ND	ND	0.17	ND	ND	0.21	ND	ND
NICKEL	28.00	1.60E+03	9.50	14.10	14.90	17.60	19.80	16.30	16.90	7.30
POTASSIUM	10,000.00		1,760.00	2,020.00	3,000.00	6,540.00	6,600.00	3,460.00	5,710.00	1,190.00
SODIUM	12,900.00		301.00	665.00	911.00	4,670.00	4,640.00	368.00	1,720.00	208.00
THALLIUM	1.30		0.87	0.61	0.87	1.80	1.70	1.10	1.40	0.78
VANADIUM	91.50	5.50E+02	29.90	24.50	34.50	60.00	60.70	41.40	55.70	19.60
ZINC	123.00	2.30E+04	34.10	38.90	79.10	81.30	82.80	99.60	69.00	23.20

Shaded concentrations indicate the value is above the background screening level (see text Section 5.4), except those analytes detected in the method blanks.

Not all analytes tested for are listed; those not listed were not detected (ND). For a complete list of analytes requested and tested, see Appendix C.

* -- Duplicate analysis not within control limits.

N -- Spiked sample, recovery not within control limits.

PRG -- Preliminary remediation goal, 4th quarter, 1993, residential soil classification.

TABLE 7-21
Analytes Detected in Soil--Sites 44 and 45
Volatile and Semivolatile Organics
NWS Seal Beach, Seal Beach, California

ANALYTE	BACKGROUND 45H004A0-1 (ug/kg)	PRG (ug/kg)	SAMPLE NUMBERS 44H001A0-1 (ug/kg)	44H002A0-1 (ug/kg)	45H001A0-1 (ug/kg)	45H001A0-2 (ug/kg)	45H001A1-2 (ug/kg)	45H002A0-1 (ug/kg)	45H002A0-2 (ug/kg)	45H003A0-1 (ug/kg)
SEMIVOLATILE ORGANICS										
ANTHRACENE	ND		ND	ND	10.00	ND	ND	23.00	ND	ND
BENZO(A)PYRENE	ND		ND	ND	29.00	ND	ND	49.00	ND	ND
BENZO(B)FLUORANTHENE	ND		ND	ND	16.00	ND	ND	ND	ND	ND
BIS(2-ETHYLHEXYL)PHTHALATE	27(B)	6.10E+04	32(B)	ND	94(B)	73(B)	64(B)	135(B)	26(B)	39(B)
BUTYLBENZYLPHTHALATE	ND	7.80E+06	ND	ND	11.00	ND	ND	18.00	ND	ND
CHRYSENE	ND		ND	ND	ND	ND	ND	18.00	ND	ND
DI-N-BUTYLPHTHALATE	367(B)		199(B)	232(B)	307(B)	383(B)	173(B)	307(B)	153(B)	146(B)
FLUORANTHENE	ND		ND	ND	14.00	ND	ND	20.00	ND	ND
PHENANTHRENE	ND		ND	ND	ND	ND	ND	19.00	ND	ND
PYRENE	ND	1.20E+06	ND	ND	21.00	ND	ND	27.00	ND	ND

Shaded concentrations indicate the value is above the background screening level (see text Section 5.4), except those analytes detected in the method blanks.

Not all analytes tested for are listed; those not listed were not detected (ND). For a complete list of analytes requested and tested, see Appendix C.

B -- Analyte is found in the associated blank as well as in the sample.

PRG -- Preliminary remediation goal, 4th quarter, 1993, residential soil classification.

TABLE 7-22
Analytes Detected In Groundwater - Sites 44 and 45
NWS Seal Beach, California

ANALYTE	MCL (EPA) (µg/l)	MCL (DHS) (µg/l)	44GP01A0-1 (µg/l)	Q	44GP02A0-1 (µg/l)	Q	45GP01A0-1 (µg/l)	Q	45GP01A1-1 (µg/l)	Q
METALS										
ALUMINUM		1,000.00	306.00		ND		231.00		264.00	
ANTIMONY	6.00		99.40		ND		94.40		ND	
BARIUM	2,000.00	1,000.00	148.00		181.00	BE	160.00		176.00	
CALCIUM			1,620,000.00		971,000.00	E	1,220,000.00		1,220,000.00	
COBALT			165.00		10.30	B	12.60		12.60	
IRON			70,200.00		42,000.00		105.00		265.00	
LEAD		50.00	11.30	B	15.80	N	ND		ND	
MAGNESIUM			794,000.00		889,000.00	E	1,030,000.00		1,020,000.00	
MANGANESE			11,300.00		7,150.00		1,100.00		1,110.00	
NICKEL	100.00		200.00		22.90	B	52.40		45.00	
POTASSIUM			898.00		417,000.00	E	272,000.00		276,000.00	
SILVER		50.00	10.90		ND		ND		ND	
SODIUM			4,650,000.00		7,520,000.00		7,460,000.00		7,370,000.00	
ZINC			21,500.00		245.00		17,600.00		20,300.00	
SEMIVOLATILE ORGANICS										
2-METHYLNAPHTHALENE			ND		13.00		ND		ND	
NAPHTHALENE	0.20		ND		5.00	J	ND		ND	
PHENANTHRENE	0.20		ND		3.00	J	ND		ND	
VOLATILE ORGANICS										
BENZENE	5.00	1.00	ND		4.00	J	ND		ND	
CARBON DISULFIDE			4.00	J	ND		ND		7.00	
METHYLENE CHLORIDE	5.00		6.00	B	ND		ND		3.00	JB

Not all analytes tested for are listed. Those not listed were not detected (ND).
For a complete list of analytes requested and tested for, see Table 5-4 and Appendix C.
Shaded concentrations indicate the value is above an MCL.

EPA - Environmental Protection Agency.
DHS - California Department of Health Services.
MCL - Maximum contaminant level.

Q - Qualifier.
B - Analyte is found in the associated blank as well as in the sample.
E - Concentrations exceeds the calibration range of the gas chromatography/mass spectroscopy (GC/MS) instrument.
N - Indicates presumptive evidence of a compound.
J - Indicates an estimated value, less than the contract-required quantitation limit (CRQL) and greater than zero.

Table 4.2-2
Site 1 - Summary of Detected Analytes

Metallic Compounds	B1-1-6 Soil MG/KG	B1-1-15 Soil MG/KG	B1-1-27 Soil MG/KG	B2-1-6 Soil MG/KG	B2-1-15 Soil MG/KG	B2-1-15D Soil MG/KG	B2-1-27 Soil MG/KG	B3-1-6 Soil MG/KG	B3-1-15 Soil MG/KG	B3-1-27 Soil MG/KG	B4-1-8 Soil MG/KG	B4-1-17 Soil MG/KG
Cadmium (Cd), total	10.7	6.1	3.7	8	5.7	5.1	6.4	15.2	8	3.9	7.5	6.6
Chromium (Cr), total	490	316	46.8	1050	485	134	110	426	491	267	224	91.1
Copper (Cu), total	96.9	63.6	15.6	566	274	38.7	60.5	1170	233	119	315	87.9
Nickel (Ni), total	147	135	123	162	131	106	141	449	119	89	135	74.5
Lead (Pb), total	28.4	13.3	5.1	105	19.3	4.6	10	309	18.3	13.9	21	10.6
Zinc (Zn), total	188	140	65.6	577	399	101	117	889	190	118	252	119
Total Petroleum Hydrocarbons (EPA Method 418.1)												
TPH	NR	NR	NR	NR	NR	26	NR	NR	35	NR	NR	6.7
Explosive Compounds												
Picramic Acid	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ammonia, AS N	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Note:
Blank indicates analyte not detected.
NR indicates analysis not requested.
D indicates duplicate

Table 4.2-2
Site 1 - Summary of Detected Analytes

Metallic Compounds	B4-1-29 Soil MG/KG	B4-1-29D Soil MG/KG	B5-1-9 Soil MG/KG	B5-1-18 Soil MG/KG	B5-1-30 Soil MG/KG	B6-1-8 Soil MG/KG	B6-1-17 Soil MG/KG	B6-1-29 Soil MG/KG	B7-1-8 Soil MG/KG	B7-1-17 Soil MG/KG	B7-1-30 Soil MG/KG	B7-1-17D Soil MG/KG	B8-1-8 Soil MG/KG
Cadmium (Cd), total	3.7	5.6	4.5	8.2	5.2	5.5	6	6.2	8	5.8	5.5	8.2	4.1
Chromium (Cr), total	27.7	84.7	32.3	37.9	26.7	35.9	36.3	38	38.3	32	34.1	35	17.4
Copper (Cu), total	14.4	110	21	26.5	15.7	29.5	30.6	29.3	29	25.7	23.3	27.8	8.5
Nickel (Ni), total	95.6	97.2	126	157	114	140	107	101	140	100	120	99.9	117
Lead (Pb), total	4	11.9	10.1	18.3	11.4	14.2	9.5	12	10.4	9.6	8	8.9	5.8
Zinc (Zn), total	54.6	107	91.7	116	73.6	106	90.4	114	101	92.3	91.4	99.2	56.4
Total Petroleum Hydrocarbons (EPA Method 418.1)													
TPH	NR	NR	100	NR	NR	24	NR	NR		NR	NR	11	NR
Explosive Compounds													
Picramic Acid	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Ammonia, AS N	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	1.4

Note:
Blank indicates analyte not detected.
NR indicates analysis not requested.
D indicates duplicate

Table 4.2-2
Site 1 - Summary of Detected Analytes

Metallic Compounds	B8-1-17 Soil MG/KG	B8-1-29 Soil MG/KG	B9-1-80 Soil MG/KG	B9-1-8 Soil MG/KG	B9-1-17 Soil MG/KG	B9-1-29 Soil MG/KG
Cadmium (Cd), total	3.5	3.6	4.8	3.4	3.2	2.3
Chromium (Cr), total	22	18.1	22.4	18.7	21.2	19.9
Copper (Cu), total	10.9	6.1	12.9	8.9	12.6	8
Nickel (Ni), total	96	109	111	104	80.6	105
Lead (Pb), total	6	4.4	12.8	6.6	6.9	4.1
Zinc (Zn), total	62.3	62	66.6	58.6	60.2	56.2
Total Petroleum Hydrocarbons (EPA Method 418.1)						
TPH	NR		NR	NR	14	NR
Explosive Compounds						
Picramic Acid				2.8	NR	NR
Ammonia, AS N	1.4			2.1	NR	NR

Note:
Blank indicates analyte not detected.
NR indicates analysis not requested.
D indicates duplicate

Table 4.4-3
Site 4 - Summary of Detected Analytes

Semi-Volatile Organic Compounds (EPA Method 8270)	B17-4-11 Soil MG/KG	B18-4-12 Soil MG/KG	B19-4-11 Soil MG/KG	B20-4-10 Soil MG/KG	B20-4-10D Soil MG/KG	B21-4-10 Soil MG/KG	B22-4-12 Soil MG/KG	B23-4-12 Soil MG/KG	B24-4-10 Soil MG/KG	B25-4-10 Soil MG/KG	B26-4-11 Soil MG/KG
Benzo(a)anthracene											
N-Nitrosodiphenylamine			7.64								
Pyrene			3.08								
Metallic Compounds											
Arsenic (As), total	12	12	13	15	15	14	12	16	16	16	20
Cadmium (Cd), total	3.65	3.66	3.32	3.42	3.56	3.51	3.12	4.4	4.32	4.31	4.46
Chromium (Cr), total	16.6	17.6	18.6	75.7	18.9	22.1	20.4	20	23.2	22.9	25.1
Copper (Cu), total	19.6	17.5	15.9	22.9	12.4	16	13.3	19.6	24.4	21.9	23.2
Mercury (Hg), total									1.1 j		
Nickel (Ni), total	12.7	13.7	11.7	17.2	12.8	12.6	12.1	14.3	17.2	17.6	21.5
Lead (Pb), total	6.8	12.2	145	206	23.7	56.5	40.5	5.14	6.1	11.9	14.9
Zinc (Zn), total	55.2	56.5	74.2	152	59.6	90.9	60.4	63.3	63	66.3	77.3
Organochlorine Pesticide/ PCB Compounds (EPA Method 8080)											
Dieldrin							0.005				
4,4'-DDE						0.97	0.030			0.009	0.045
4,4'-DDD				0.041			0.014				
4,4'-DDT						1.32	0.026			0.009	0.034
Dioxin, Furan Compounds	ng/g			ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	
PCDD's:											
HxCDD									0.34		
HpCDD									0.48	2	
OCDD	0.066			5.5	0.89	1	0.42	0.013	1.7	4.4	
PCDF's:											
OCDF										0.20	

Note:
Blank indicates analyte not detected.
j indicates detected below detection limit.
D indicates duplicate.

Table 4.4-3
Site 4 - Summary of Detected Analytes

Semi-Volatile Organic Compounds (EPA Method 8270)	B27-4-12 Soil MG/KG	B28-4-12 Soil MG/KG	B28-4-12D Soil MG/KG	B29-4-9 Soil MG/KG	B30-4-12 Soil MG/KG	B31-4-12 Soil MG/KG	B32-4-12 Soil MG/KG	B33-4-12 Soil MG/KG	B34-4-12 Soil MG/KG	B34-4-12D Soil MG/KG	B35-4-12 Soil MG/KG
Benzo(a)anthracene	2.49										
N-Nitrosodiphenylamine											
Pyrene											
Metallic Compounds											
Arsenic (As), total	16	16	17	15	9.3 j	19	15	10	18	14	18
Cadmium (Cd), total	4.51	4.57	4.58	4.42	3.34	4.45	4.14	3.29	4.25	4.53	3.78
Chromium (Cr), total	99.9	21.7	23.3	27.1	22.8	53.7	19.3	15.8	42.4	20.6	20
Copper (Cu), total	24.7	21.8	22.6	18.7	14.5	23.1	14.9	12.8	24.5	19.9	21.2
Mercury (Hg), total	1.1 j			1.1 j	1.9 j	1.1 j	1.4 j				
Nickel (Ni), total	21.3	16.1	16.9	16.6	12.9	17.1	13.4	10.4	19.2	14.8	16.1
Lead (Pb), total	77.7	8.9	9.47	21.1	29.1	45.7	4.4	3.3	122	8.48	5.99
Zinc (Zn), total	137	81.2	81.7	76.9	75.7	103	66.4	49.4	111	75.7	57.8
Organochlorine Pesticide/ PCB Compounds (EPA Method 8080)											
Dieldrin											
4,4'-DDE		0.006		0.046	0.82	0.125	0.037		0.011	0.006	
4,4'-DDD											
4,4'-DDT	0.081			0.084	1.28	0.161			0.011	0.006	
Dioxin, Furan Compounds			ng/g	ng/g		ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
PCDD's:											
HxCDD											
HpCDD					4.1						
OCDD			0.012	0.18		1.8	0.019	0.0053	3.0	0.037	0.76
PCDF's:											
OCDF											

Note:
Blank indicates analyte not detected.
j indicates detected below detection lim
D indicates duplicate.

Table 4.4-3
Site 4 - Summary of Detected Analytes

Semi-Volatile Organic Compounds (EPA Method 8270)	B36-4-12 Soil MG/KG	B37-4-12 Soil MG/KG
Benzo(a)anthracene		
N-Nitrosodiphenylamine		
Pyrene		
Metallic Compounds		
Arsenic (As), total	13	20
Cadmium (Cd), total	3.86	5.07
Chromium (Cr), total	19.5	23.1
Copper (Cu), total	18.6	22.4
Mercury (Hg), total		
Nickel (Ni), total	13.5	16
Lead (Pb), total	9.08	10.1
Zinc (Zn), total	64.8	76.5
Organochlorine Pesticide/ PCB Compounds (EPA Method 8080)		
Dieldrin		
4,4'-DDE	0.034	
4,4'-DDD		
4,4'-DDT	0.038	
Dioxin, Furan Compounds		ng/g
PCDD's:		
HxCDD		
HpCDD		0.72
OCDD		5.0
PCDF's:		
OCDF		

Note:
Blank indicates analyte not detected.

Table 4.6-4
Site 7 - Summary of Detected Analytes
Soil Samples

Volatile Organic Compounds (EPA Method 8240)	BLANK Soil ug/kg	W41-7-1 Soil ug/kg	W41-7-5 Soil ug/kg	W41-7-5D Soil ug/kg	W41-7-10 Soil ug/kg	W42-7-1 Soil ug/kg	W42-7-5 Soil ug/kg	W42-7-10 Soil ug/kg	W43-7-1 Soil ug/kg	W43-7-5 Soil ug/kg	W43-7-10 Soil ug/kg	W43-7-10D Soil ug/kg
Methylene chloride	8	600 b	580 b	400 b	510 b	380 b	350 b	310 b				
Toluene									190		9.3	34
Metallic Compounds		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Silver (Ag), total												5.6
Arsenic (As), total		2.6	4.4	2.9	3.6	15.5	1.9	1.5	NR	NR	NR	NR
Cadmium (Cd), total						0.7			NR	NR	NR	NR
Chromium (Cr), total		17.5	32.3	28.9	24.6	86.6	11.8	13.6	24.3	26	53.4	37.2
Copper (Cu), total		26	35.9	64.2	26.7	68.8	9.6	15.2	NR	NR	NR	NR
Mercury (Hg), total		0.15		0.15		0.91			0.5	0.67	0.58	0.58
Nickel (Ni), total		12	21	21	12	21	7	11	19.1	19.8	27.4	16.8
Lead (Pb), total		28	21	19	14	2080	10	9	5.7	2.8	6.6	5.2
Zinc (Zn), total		126	94	92	65	437	43	72	85.4	66.6	112	88.8
Semi-Volatile Organic Compounds (EPA Method 8270)		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Chrysene									160			
Di-n-butyl phthalate									170			
Fluoranthene									120			
4-chloro-3-methylphenol												

Note:
Blank indicates analyte not detected.
NR indicates analysis not requested.
b indicates present in blank.
D indicates duplicate.

Table 4.6-4 (continued)
Site 7 - Summary of Detected Analytes
Soil Samples

Volatile Organic Compounds (EPA Method 8240)	W44-7-1 Soil ug/kg	W44-7-5 Soil ug/kg	W44-7-10 Soil ug/kg	W45-7-1 Soil ug/kg	W45-7-5 Soil ug/kg	W45-7-10 Soil ug/kg	W45-7-10D Soil ug/kg	W46-7-1 Soil ug/kg	W46-7-5 Soil ug/kg	W46-7-10 Soil ug/kg	S47-7-6 Soil ug/kg	S47-7-15 Soil ug/kg
Methylene chloride												
Toluene	38	65	17	460	120	260	310	38	18	13	550	41
Metallic Compounds	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Silver (Ag), total	2.6	3.4	3.3									
Arsenic (As), total	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium (Cd), total	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Chromium (Cr), total	28.6	25.8	51.7	24.1	33.2	36.4	31.7	35.2	28.2	41	35.1	22
Copper (Cu), total	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Mercury (Hg), total	0.39	0.5	0.59	0.5	0.77	1.5	1.5					
Nickel (Ni), total	15.9	13.7	50.8	15.6	20.6	22.3	19.1	18.5	20.2	30.7	23.6	17.2
Lead (Pb), total	13.1	2.8	9.8	6.4	6.1	9.8	8.2	4.7	5.1	6.8	75	3.1
Zinc (Zn), total	74.3	114	134	84.6	92.4	110	93.9	92.4	86.5	104	115	77.5
Semi-Volatile Organic Compounds (EPA Method 8270)	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Chrysene												
Di-n-butyl phthalate												
Fluoranthene												
4-chloro-3-methylphenol		120										

Note:
Blank indicates analyte not detected.
NR indicates analysis not requested.
b indicates present in blank.
D indicates duplicate.

Table 4.6-4 (continued)
Site 7 - Summary of Detected Analytes
Soil Samples

Volatile Organic Compounds (EPA Method 8240)	S47-7-27 Soil ug/kg	S47-7-27D Soil ug/kg	S48-7-6 Soil ug/kg	S48-7-15 Soil ug/kg	S48-7-27 Soil ug/kg	S49-7-6 Soil ug/kg	S49-7-15 Soil ug/kg	S49-7-27 Soil ug/kg
Methylene chloride								
Toluene	140	79	480	340	300	670	1200	160
Metallic Compounds	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Silver (Ag), total		4.3						
Arsenic (As), total	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium (Cd), total	NR	NR	NR	NR	NR	NR	NR	NR
Chromium (Cr), total	26.7	27.9	43.4	27.8	44.1	34.4	32.6	25.2
Copper (Cu), total	NR	NR	NR	NR	NR	NR	NR	NR
Mercury (Hg), total								
Nickel (Ni), total	20.9	27	33.9	24.1	29.4	29	28.6	19.5
Lead (Pb), total	3.5	2.4	24.1	3.7	7.9	28.9	12.7	4.3
Zinc (Zn), total	63.3	76.8	156	78.1	120	106	96.7	81.2
Semi-Volatile Organic Compounds (EPA Method 8270)	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Chrysene								
Di-n-butyl phthalate								
Fluoranthene								
4-chloro-3-methylphenol								

Note:
Blank indicates analyte not detected.
NR indicates analysis not requested.
b indicates present in blank.
D indicates duplicate.

Table 4.6-4
Site 7 - Summary of Detected Analytes
Water Samples

Volatile Organic Compounds (EPA Method 624)	BLANK Water ug/l	W41-7-W Water ug/l	W41-7-WD Water ug/l	W42-7-W Water ug/l	W43-7-W Water ug/l	W44-7-W Water ug/l	W45-7-W Water ug/l	W46-7-W Water ug/l	BLANK Water ug/l	S47-7-W Water ug/l	S48-7-W Water ug/l	S48-7-WD Water ug/l
Methylene chloride									8	1 jb	2 jb	2 jb
Acetone		99	130						5	6 jb	4 jb	
Carbon disulfide				1 j								
4-Methyl-2-pentanone		9 j	10									
Semi-Volatile Organic Compounds (EPA Method 625)												
Benzo(a)anthracene						7 j						
Bis(2-ethylhexyl) phthalate	7	3 jb		2 jb	2 jb	5 j				2 j		
Di-n-butyl phthalate						9 j						
Hexachlorobenzene						11						
Phenanthrene						15						
Pyrene						11						
N-nitrosodiphenylamine				2 j								
4-bromophenyl-phenylether						9 j						
Metallic Compounds												
Silver (Ag), total					252							
Chromium (Cr), total		78.3	112	136	77.2	402	194	188		65.3	47.8	72.3
Mercury (Hg), total		8.1										
Nickel (Ni), total		67	86.5	89.3		270	168	122		82	74.2	63.3
Lead (Pb), total												
Zinc (Zn), total		194	180	261	132	932	438	403			118	23

Note:
Blank indicates analyte not detected.
j = present below detection limit
b = present in blank

Table 4.6-4 (continued)
Site 7 - Summary of Detected Analytes
Water Samples

Volatile Organic Compounds (EPA Method 624)	S49-7-W Water ug/l
Methylene chloride	2 jb
Acetone	3 jb
Carbon disulfide	
4-Methyl-2-pentanone	
Semi-Volatile Organic Compounds (EPA Method 625)	
Benzo(a)anthracene	
Bis(2-ethylhexyl) phthalate	
Di-n-butyl phthalate	
Hexachlorobenzene	
Phenanthrene	
Pyrene	
N-nitrosodiphenylamine	
4-bromophenyl-phenylether	
Metallic Compounds	
Silver (Ag), total	
Chromium (Cr), total	69.1
Mercury (Hg), total	
Nickel (Ni), total	104
Lead (Pb), total	
Zinc (Zn), total	

Note:
Blank indicates analyte not detected.
j = present below detection limit
b = present in blank

Table 4.9-2
Site 22 - Summary of Detected Analytes
Soil Samples

Aromatic Volatile Organic Compounds (EPA Method 8020)	S58-22-6 Soil MG/KG	S58-22-15 Soil MG/KG	S58-22-35 Soil MG/KG	S59-22-6 Soil MG/KG	S59-22-15 Soil MG/KG	S59-22-15D Soil MG/KG	S59-22-27 Soil MG/KG	S59-22-35 Soil MG/KG	S60-22-6 Soil MG/KG	S60-22-16 Soil MG/KG
Toluene	0.21			0.076	0.13		0.13			0.10
Metallic Compounds										
Arsenic (As), total										38
Chromium (Cr), total	14	78	10	6.8	31	29	32		38	19
Nickel (Ni), total	20	49		8.6	22	24	20		35	
Vanadium (V), total	42	183	24	16	69	66	68		68	42
Total Petroleum Hydrocarbons (EPA Method 418.1)										
TPH							87		105	52

Note:
Blank indicates analyte not dectected.
D indicates duplicate.

Table 4.9-2
Site 22 - Summary of Detected Analytes
Soil Samples

Aromatic Volatile Organic Compounds (EPA Method 8020)	S60-22-27 Soil MG/KG	S60-22-27D Soil MG/KG	S61-22-15 Soil MG/KG	S61-22-27 Soil MG/KG	S61-22-34 Soil MG/KG	S62-22-6 Soil MG/KG	S62-22-17 Soil MG/KG	S62-22-27 Soil MG/KG	S63-22-7 Soil MG/KG	S63-22-17 Soil MG/KG
Toluene		0.47				1.1			0.71	0.38
Metallic Compounds										
Arsenic (As), total		16					10		11	27
Chromium (Cr), total	41	32	46	33	35	37	38	31	40	38
Nickel (Ni), total	23	19	31	23	26	28	10	27	22	26
Vanadium (V), total	86	71	81	75	76	28	19	63	71	76
Total Petroleum Hydrocarbons (EPA Method 418.1)										
TPH										

Note:
Blank indicates analyte not dectected.
D indicates duplicate.

Table 4.9-2
Site 22 - Summary of Detected Analytes
Soil Samples

Aromatic Volatile Organic Compounds (EPA Method 8020)	S63-22-27 Soil MG/KG	S64-22-18 Soil MG/KG	S64-22-27 Soil MG/KG	S64-22-27D Soil MG/KG	S65-22-6 Soil MG/KG	S65-22-17 Soil MG/KG	S65-22-27 Soil MG/KG	S66-22-7 Soil MG/KG	S66-22-18 Soil MG/KG	S66-22-18D Soil MG/KG
Toluene	0.79									
Metallic Compounds										
Arsenic (As), total	20	15				11	12	16	16	11
Chromium (Cr), total	29	37	46	36	39	42	33	36	39	34
Nickel (Ni), total	18	26	27	24	28	27	20	26	25	25
Vanadium (V), total	62	76	102	74	79	81	65	72	75	72
Total Petroleum Hydrocarbons (EPA Method 418.1)										
TPH				36	89	28		34	42	110

Note:
Blank indicates analyte not dectected.
D indicates duplicate.

Table 4.9-2
Site 22 - Summary of Detected Analytes
Soil Samples

Aromatic Volatile Organic Compounds (EPA Method 8020)	S66-22-27 Soil MG/KG	S67-22-6 Soil MG/KG	S67-22-16 Soil MG/KG	S67-22-38 Soil MG/KG	S67-22-38D Soil MG/KG	S68-22-6 Soil MG/KG	S68-22-15 Soil MG/KG	S68-22-27 Soil MG/KG	S69-22-6 Soil MG/KG	S69-22-20 Soil MG/KG
Toluene				0.20	0.19					
Metallic Compounds										
Arsenic (As), total	22	40								30
Chromium (Cr), total	67	48		31	71		39	63	73	55
Nickel (Ni), total	48	52			26	35		22	40	
Vanadium (V), total	142	124		62	79	81		80	86	45
Total Petroleum Hydrocarbons (EPA Method 418.1)										
TPH	45		86	37		42				95

Note:
Blank indicates analyte not dectected.
D indicates duplicate.

Table 4.9-2
Site 22 - Summary of Detected Analytes
Soil Samples

Aromatic Volatile Organic Compounds (EPA Method 8020)	S69-22-32 Soil MG/KG	S70-22-8 Soil MG/KG	S70-22-16 Soil MG/KG	S70-22-36 Soil MG/KG	S71-22-6 Soil MG/KG	S71-22-15 Soil MG/KG	S71-22-27 Soil MG/KG	S72-22-6 Soil MG/KG	S72-22-15 Soil MG/KG	S72-22-15D Soil MG/KG
Toluene		0.83				0.38		0.23		0.047
Metallic Compounds										
Arsenic (As), total					35					
Chromium (Cr), total	55	78	55	65	74	43	51	25	25	22
Nickel (Ni), total	21			30	44	18	20	14	14	12
Vanadium (V), total	70	61	44	97	95	57	71	49	49	42
Total Petroleum Hydrocarbons (EPA Method 418.1)										
TPH					57	79	61			

Note:
Blank indicates analyte not dectected.
D indicates duplicate.

Table 4.9-2
Site 22 - Summary of Detected Analytes
Soil Samples

Aromatic Volatile Organic Compounds (EPA Method 8020)	S72-22-27 Soil MG/KG	S73-22-7 Soil MG/KG	S74-22-5 Soil MG/KG	S75-22-5 Soil MG/KG	S76-22-5 Soil MG/KG	S76-22-50 Soil MG/KG	S81-22-6 Soil MG/KG	S82-22-6 Soil MG/KG	S82-22-18 Soil MG/KG	S82-22-30 Soil MG/KG
Toluene				0.28	1.8	0.071	0.085			
Metallic Compounds										
Arsenic (As), total	8.5	31	33	30	55	9.5				
Chromium (Cr), total	23	54	54	70	44	48	33	29	25	24
Nickel (Ni), total	16	27	23	23	27	30	13	25		
Vanadium (V), total	48	58	44	46	45	61	44	56	71	65
Total Petroleum Hydrocarbons (EPA Method 418.1)										
TPH		84	3600	279	467	143	107	100	84	

Note:
Blank indicates analyte not dectected.
D indicates duplicate.

Table 4.9-2
Site 22 - Summary of Detected Analytes
Bioaccumulation Samples

Volatile Organic Compounds (EPA Method 8240)	S58-22-A	S58-22-B	S59-22-A	S60-22-A1	S61-22-A1	S62-22-A	S63-22-A1	S64-22-A	S65-22-A
	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg
Methylene Chloride	75 j	100 j	90 j	79 j	80 j	70 j	50 j	90 j	110 j
Acetone	930 b		950 b		450 jb		380 jb	200 jb	290 jb
2-Butanone	450 j								
4-Methyl-2-pentanone									
2-Hexanone			200 j						
Toluene	50 j	120 j	450					75 j	
Chlorobenzene									
Semi-Volatile Organic Compoounds (EPA Method 8270)	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Benzoic Acid									
Benzyl alcohol									
Bis(2-ethylhexyl)phthalate							260 j		
Indeno(1,2,3-cd)pyrene									
4-Methylphenol	440 j		180 j						
N-Nitrosodiphenylamine	74 j								70 j
Pentachlorophenol					700 j				
Phenol	92 j								
Metallic Compounds	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Arsenic (As), total	0.34	0.045	0.51	0.56	0.53	0.46	0.64	0.73	
Chromium (Cr), total	1.6	3.9	1.5	2.8	1.3	2.9	6	4.7	4.9
Mercury (Hg), total	1	0.63				0.5		0.12	0.12
Nickel (Ni), total	1.8	29.1	1.4	16.4	1.9	15.8	29.9	20.8	30.5
Vanadium (V), total	1.4	1.2	1.1		0.98		1.8	2.3	2.7

Note:
Blank indicates analyte not detected.
j = present below detection limit
b = present in blank

Table 4.9-2 (continued)
Site 22 - Summary of Detected Analytes
Bioaccumulation Samples

Volatile Organic Compounds (EPA Method 8240)	S66-22-A	S66-22-B2	S67-22-A1	S67-22-A3	S68-22-A1	S71-22-A1	S72-22-A1	S72-22-B2	S72-22-C2
	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg	BIOACCUM ug/kg
Methylene Chloride	150 j	120 j	59 j	130 j	180 j	130 j	50 j	850 j	80 j
Acetone	310 jb	980 b		350 jb	800 b	1200 b	390 jb	190 jb	550 b
2-Butanone									
4-Methyl-2-pentanone		630							
2-Hexanone									
Toluene	95 j						460		65 j
Chlorobenzene								70 j	
Semi-Volatile Organic Compoounds (EPA Method 8270)	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Benzoic Acid									
Benzyl alcohol									
Bis(2-ethylhexyl)phthalate						310 j		280 j	500 j
Indeno(1,2,3-cd)pyrene							110 j		
4-Methylphenol									
N-Nitrosodiphenylamine							99 j	160 j	170 j
Pentachlorophenol					1200 j				
Phenol						76 j			
Metallic Compounds	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Arsenic (As), total	0.51	0.26	0.61	0.99	0.41	0.61	0.49	0.46	0.43
Chromium (Cr), total	4	5.7	3.8	0.27	3.3	2.7	3.7	0.82	1.3
Mercury (Hg), total	0.37	0.64		0.48		0.12	0.7		0.61
Nickel (Ni), total	21.4	25.5	22.1		22.4	18.7	23.7	2.7	2.9
Vanadium (V), total	1.5	0.97	1.5		1.1		1.5		0.96

Note:
Blank indicates analyte not detected.
j = present below detection limit
b = present in blank

Table 4.9-2 (continued)
Site 22 - Summary of Detected Analytes
Bioaccumulation Samples

Volatile Organic Compounds (EPA Method 8240)	S72-22-D3 BIOACCUM ug/kg	BLANK FOR S64-22-A ug/kg	BLANK FOR S58-22-A,S58-22-B S59-22-A,S65-22-AB S66-22-AB ug/kg	BLANK FOR S62-22-A,S62-22-B2 S72-22-A1,S72-22-B2 S72-22-C2 ug/kg	BLANK FOR S63-22-A1 ug/kg	BLANK FOR S60-22-A1,S61-22-A1 S67-22-A1,S67-22-A3 S68-22-A1,S71-22-A1 ug/kg	BLANK FOR S72-22-D3 ug/kg
Methylene Chloride	80 j				2 j		
Acetone	1100 b	2 j	8 j	2 j	7 j	8 j	8 j
2-Butanone							
4-Methyl-2-pentanone							
2-Hexanone							
Toluene							
Chlorobenzene							

Semi-Volatile Organic Compoounds (EPA Method 8270)	ug/kg
Benzoic Acid	410 j
Benzyl alcohol	140 j
Bis(2-ethylhexyl)phthalate	
Indeno(1,2,3-cd)pyrene	
4-Methylphenol	
N-Nitrosodiphenylamine	190 j
Pentachlorophenol	
Phenol	

Metallic Compounds	mg/kg
Arsenic (As), total	0.88
Chromium (Cr), total	0.39
Mercury (Hg), total	
Nickel (Ni), total	
Vanadium (V), total	

Note:
Blank indicates analyte not detected.
j = present below detection limit
b = present in blank